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AMERICAN RAILWAY JOURNAL.

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NEW GOVERNMENT DRY DOCKS to cost $11,000,000 are recommended by the special Board of Experts appointed by the Secretary of the Navy to investigate the necessity of better accommodations for dry docking United States vessels of war and to report upon the number, character, location and cost of the new docks needed. According to the outline of the report given in the press dispatches from Washington these additional dry docks are necessary, at the Boston navy yard, one concrete graving dock, 700 ft. long, $1,300,000; at the New York navy yard, one concrete graving dock, 500 ft. long, $1,200,000; at the Norfolk navy yard, one concrete graving dock, 500 ft. long, $1,100,000, and the lengthening of the present stone dock to 450 ft., to enable it to take all cruisers except the New York and Brooklyn, $250,000; at Newport News, a steel double-sided combined floating and graving dock; at Algiers, La., opposite New Orleans, a double-sided steel floating dock of the combined floating and graving self-docking type, $750,000; at Mare Island, Cal., a dock similar to those recommended for New York and Norfolk, if the channel is improved, 500 ft. long, $1,100,000; at New London, Conn., the construction of canal locks which may form a dry dock for the largest vessels if a fresh water basin is established, $1,000,000; at Tortugas, Fla., a double-sided steel floating and graving dock, $650,000; at Yerba Buena Island, Cal., in San Francisco Bay, a double-ended dock of concrete, if a survey of the character of the geological formation of the island gives satisfactory results; at San Pedro, Cal., a concrete dock in connection with the proposed harbor improvements. The total sum recommended for the construction of these docks is $11,075,000, of which $5,775,000 is for five docks urgently needed at New York, Boston, Norfolk, New Orleans and Mare Island. It is recommended that the dock at the New York navy yard shall be of the concrete graving type, 500 ft. long, 90 ft. wide on the side, with a depth of 30 ft. over the side.

A FLEET OF FIVE TORPEDO BOATS, under the command of Lieutenant Commander Kimball, U. S. N., will leave New York, on Oct. 1, for a cruise down the Atlantic coast, into the Gulf of Mexico, and finally up the Mississippi River, possibly to St. Louis. The commander will stop at his discretion, explore the coast waters, and use actual torpedoes under sea conditions. The purpose is to test the quality and endurance of the machinery of these boats and better to train the officers and men in torpedo boat practice.

A NEW STEERING DEVICE FOR TORPEDOES, known as the "Obry gear," has been tested at the proving grounds of the E. W. Bliss Co., manufacturers of submarine projectiles, at Sag Harbor, Long Island, and the results are said to have proved highly satisfactory. Torpedoes discharged from a vessel under full steam are liable to have their direction changed so that in a run of 800 yds. they may deviate as much as 150 yds. from the center of the target. The new steering device keeps the torpedo pointed in its original direction in spite of the deviating influence of currents or obstructions. The means used consists of two vertical rudders, one each side of the propeller, connected by rods to a gyroscopic spinning wheel placed within the body of the torpedo and kept in rotation by the force supplied by a coiled spring. The nature of the gyroscope is to resist any change in the direction of its axis, and this causes it to move the rudders if the direction of the torpedo is changed, and thus to bring it back to its original direction.

A NEW TRANSATLANTIC RECORD, from Southampton to Sandy Hook, has been made on the maiden trip of the North-German Lloyd's new steamer "Kaiser Wilhelm der Grosse." The record is 5 days, 22 hours 35 minutes, from the Needles, off Southampton, to Sandy Hook lightship, a course of 3,050 knots. The average speed was 21.39 knots per hour. The days' runs were as follows: 208, 531, 495, 512, 554, 564, and 186 knots. The previous record over the same course, held by the American Line steamer, "St. Paul," was 6 days 31 minutes. The average speed is not equal to the record made by the Cunard steamer "Lucania," on the course between Liverpool and Sandy Hook, which is 22.1 knots. The highest day's run however, beats the previous record of 562 knots, which was held by the "Lucania." The best hourly speed hitherto made from Southampton was made by the "St. Paul," 21.08 knots.

The records made by steamers of different lines on the Southampton-Sandy Hook course during the last four years, are as follows:

	Date.	Days.	Hrs.	Mins.
"Paris"	July 21, 1893.	6	9	37
"Columbia"	Oct. 27, 1893.	6	15	58
"Havel"	Nov. 15, 1893.	6	16	5
"New York"	Sept. 14, 1894.	6	7	14
"Fuerst Bismarck"	Sept. 27, 1894.	6	10	32
"St. Louis"	Aug. 7, 1895.	6	2	24
"St. Paul"	Aug. 14, 1896.	6	0	31
"K. Wilhelm der Grosse"	Sept. 26, 1897.	5	22	35

The "Kaiser Wilhelm der Grosse" is now the largest steamship afloat, and the largest that has yet been built, with one exception, the "Great Eastern." A comparison of the dimensions of these two vessels with those of the "Campania" and "Lucania," sister ships of the Cunard Line, and the "St. Louis" and "St. Paul," sister ships of the American Line, is as follows:

	"Great Eastern."	"Campania" and "Lucania."	"Kaiser Wilhelm der Grosse."	"St. Louis" and "St. Paul."
Year built	1856	1893	1897	1895
Length over all, ft.	697	622	649	554[3]
Between perpendiculars, ft	680	600	625	535[2]
Beam, ft.	83	65[2]	66	63
Depth from upper deck, ft.	58	41[4]	43	42
Draft, ft.	30	...	26	26
Tonnage	19,500	13,000	14,000	11,629
Horse-power	2,700	30,000	30,000	20,000
Speed, knots	12	22.1	21.39	21.08

[1]554 ft. 2 ins. [2]535 ft. 8 ins. [3]65 ft. 3 ins. [4]41 ft. 6 ins.

Other dimensions of the "Kaiser Wilhelm der Grosse" are the following: Engines, two triple expansion, four-cylinder, diameters 32, 89¾ and two 96½ ins. Propellers, bronze, each 22 ft. 3¾ ins. diameter, 32 ft. 10 ins. pitch; weight of each, 26 tons. Crank shafts of nickel steel, 24 ins. diameter; length, 198 ft. Condensers, cooling surface, total, 35,522 sq.ft.; tubes, 11,060 in number. Smokestacks, four, each 12 ft. 2 ins. diameter; height above keel, 106 ft. The "Kaiser Wilhelm der Grosse" was built and equipped with engines, etc., by the Vulcan Iron Works, Stettin. The independent air pumps, said to be the largest in the world, are of American manufacture, having been built by the Geo. F. Blake Mfg. Co. of New York city. This make of pump is in use in several of the United States battleships and cruisers. The German engineers are said to have become acquainted with these pumps during the visit of the cruiser New York to Kiel at the time of the naval celebration of the opening of the Kiel canal. Each pump has two double-acting vertical steam cylinders 18 × 22 ins., and two single-acting vertical air cylinders, 18 × 44 ins. The piston rods of the air cylinders are connected by a beam. During the voyage of the "Kaiser Wilhelm" the pumps maintained a vacuum of 27 ins. with a speed of only 15 double strokes per minute, the power used by the pumps being only 0.19 of the power of the main engines. This record is said to have never before been equaled. The volume swept through by the air-pump piston was only 1-80th of the volume of the cylinders of the main engines.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a locomotive boiler explosion on the Northern Central Ry., Sept. 27, at Georgetown, Pa., a few miles north of Harrisburg, resulting in the death of the engineer and serious injury of the firemen, who were both blown to some distance. The boiler was thrown fully 150 ft. up the side of the mountain, while trucks and tender were blown in different directions. All the cars were derailed except the rear Pullman, but none of the passengers were injured. The engine is said to have been just out of the repair shops.

A SERIOUS RAILWAY ACCIDENT is reported from Bombay, India. According to the latest advices, a bridge on the Bangalore-Mysore R. R., near Maddur, gave way while a train was crossing. The five cars were crowded with natives, 150 of whom are reported killed and 14 injured.

THE SAFETY OF PASSENGER TRAVEL on steam vessels is well illustrated by the annual report for 1897 of Gen. Dumont, Supervising Inspector-General of Steam Vessels, which has just been issued. During the year covered by the report 650,000,000 passengers were carried and the number of accidents resulting in the loss of life was 26. The number of lives lost in these accidents was 183, of which 46 were passengers and 137 were employees. The report also shows that from Jan. 1, 1871, to June 30, 1897, a period of 26½ years, the average annual loss of life has been 239 or only one person to each 1,882,845 passengers carried.

THE REPORT OF THE METROPOLTIAN STREET R. R. Co., of New York city, for the year ending June 30, 1896, has just been filed. The total number of passengers carried, including transfers, was 234,705,704, while 56,929,611 transfers were issued. If we deduct transfers and consider Manhattan as containing 1,800,000 inhabitants, this would mean nearly 90 rides for every man, woman and child living on the island. The gross earnings were $8,888,804; operating expenses, $4,810,235; net earnings, $4,078,569; other income, $547,529; fixed charges, $3,186,976; net income, $1,439,122; 4% dividend declared on $30,000,000, amounting to $1,200,000; total surplus, $1,332,488; cash on hand, $295,013. The casualty list shows 16 passengers injured and 2 killed; 2 employes were killed and 2 injured, while 19 persons not passengers or employes were injured and 8 killed. The total was 37 persons injured and 12 killed.

CONDUIT ELECTRIC RAILWAYS have assumed commercial form, and are rapidly supplanting other systems of surface transit in New York city. Since the Metropolitan Railway Co. determined to change its motive power a large force has been at work installing the new roadbed. The total weight of the conduit construction is 500 lbs. per yd. of single track, distributed as follows: Two rails, 107 lbs. each; two slot rails, 58 lbs. each; two conductor rails, 21 lbs. each; metal lining, 16 lbs. The cast-iron yokes weigh 410 lbs. each, except the hand-hole yokes which are arranged to support the heavy porcelain insulators and iron conductor hangers, and weigh 610 lbs. each.

A THREE-PHASE RAILWAY SYSTEM will be installed between Varese and Luino, in Northern Italy, near Milan, by the French branch of the General Electric Co. The distance between the two places is 27 kilometers (16¾ miles), with a branch of 5 kilometers (3 1-10 miles). There are two main grades—a long one of 4½% on which a speed of 35 kilometers per hour (21¾ miles) is called for, and a shorter grade of 7½% up which the cars must travel at 20 kilometers per hour (12 4-10 miles). There will be one central station, containing three-phase generators directly connected to turbines. The line voltage will be 6,000, with a frequency of 45 cycles, which will be stepped down at intervals by static transformers placed on the poles, to the usual railway voltage of 550, at which pressure it will be fed to the twin trolley wires and track. Eight trains composed of three cars will be run, which will have a total weight of 26 long tons, including two 70-HP. iron-clad three-phase motors, which will be guaranteed to meet all requirements. The method of control will be what is termed the "catinated" system. Three collector rings will be provided and a controller connected in such a way as to give two speeds—half and full. The contract allows about a year for completion and all machinery will be manufactured by the General Electric Co., at its Schenectady works.

A SANITARY SEWERAGE SYSTEM FOR BALTIMORE, with disposal by dilution, has been recommended by the sewerage commission of that city, consisting of Messrs. Mendes Cohen, Past-President Am. Soc. C. E.; F. H. Hambleton, M. Am. Soc. C. E., and E. L. Bartlett. Messrs. Samuel M. Gray and Rudolph Hering, Members Am. Soc. C. E., are mentioned in the report as consulting engineers to the commission. The report recommends that the separate system be adopted, and that the sewage be discharged continuously into Chesapeake Bay. The cost of a system for the whole city is estimated at $10,495,167, of which about $6,000,000 would provide for some 330,000 persons, or the area likely to be served by the time the system would be put in operation. Excellent land for intermittent filtration is available, but this system would cost much more than the plan recommended and is not deemed necessary. The commission favors a slight yearly fee for the use of the sewers as a means of raising money for operating expenses, interest charged and a sinking fund.

A BOND ISSUE OF $12,200,000 is to be voted on by the people of Philadelphia at the coming November election. The principal purposes of the issue are as follows: $3,700,000 for extension, improvement and filtration of the water supply; $2,000,000 for pavements; $1,000,000 each for improvements to the gas works and for a library site and building; $900,000 for abolishing grade crossings on the Philadelphia & Trenton R. R.; $600,000 for bridges, and $500,000 for sewers.

THE RESULT OF A STEAMSHIP'S COLLISION WITH AN ICEBERG.

The accompanying engraving is reproduced from a photograph of the bow of an English freight steamer which came into collision with an iceberg last spring, but fortunately survived the shock. The manner in which the steel plates of the hull have been doubled up and crumpled by the force of the blow is very interesting. The vessel to which this accident occurred is the "Knight Bachelor," of the Knight Line, of Liverpool, usually employed in the Indian trade, and is a large, well-built modern freight steamer, intended specially for carrying grain in bulk. On April 26, 1897, while crossing the Atlantic in ballast, on the way to Norfolk, Va., for a grain cargo, the ship struck an iceberg about 500 ft. long and rising about 15 ft. out of the water. The collision occurred during a fog, the ship running at a speed of about 9 or 10 knots. Had the vessel been deeply loaded, and carrying its full cargo capacity of 9,300 tons, the force of the blow would very likely have been sufficient to crush in the bow beyond the collision bulkhead, and to cause the vessel to founder, but as it was riding light with only 2,300 tons of water ballast, the blow only crushed in the shell plating and frames of the bow, the collision bulkhead being uninjured and sustaining the pressure of the water against it. This pressure was soon relieved by pumping out the water ballast, so that the vessel had a draft of only 4 ft. of water at the bow. The vessel put into Halifax, N. S., and was repaired by the Halifax Dry Dock Co., as noted in our issue of Aug. 26, the new plates, frames, etc., being sent out from the builders' yards in Scotland.

The steamer has a length of 475 ft. over all; beam, 52 ft. 6 ins.; depth of hold, 36 ft.; loaded draft, 20 ft.; tonnage, 4,000 tons net register; normal sea speed, 11½ knots; maximum speed, 13 knots. It has a single screw, 18 ft. 6 ins. diameter, and 19 ft. 9 ins. pitch, driven by a triple expansion engine of 3,500 I. HP. It is interesting to note that this vessel requires 35 tons of coal per day for its regular speed of 11½ knots, while for the full speed of 13 knots it requires nearly 60 tons per day. The ship was built about three years ago at Connel's shipyards, in Glasgow, Scotland. Capt. Thomas is in command of the vessel, and our information was obtained on board, at Halifax, from Mr. Robert S. Mitchell, Second Engineer, and Mr. Handy, Second Officer.

View of Bow of the Steamer "Knight Bachelor" after Collision with an Iceberg.

RAISING THE METROPOLITAN WEST SIDE ELEVATED RAILWAY OF CHICAGO.

(With two-page plate.)

The elevation of a part of the structure of the Metropolitan West Side Elevated R. R. has been made necessary by the elevation of the tracks of the Chicago & Northwestern Ry. and Pittsburg, Cincinnati, Chicago & St. Louis Ry. along Rockwell St., which latter work is a part of the extensive work now in progress in Chicago for the elimination of railway crossings at grade. The Garfield Park line of the elevated railway crosses these tracks at Rockwell St., between Van Buren and Congress Sts., and as the line was built and in operation, the changing of the grade had to be planned and executed with considerable care.

The structure has plate-girder deck spans, with four rows of girders supported by two rows of latticed columns, the tops of these columns flaring out to a top width sufficient to support two girders 5 ft. apart. The two inner rows of girders are 7 ft. apart. At alternate spans there are curved knee-braces riveted to the sides of the columns and to transverse channels between the girders, thus anchoring the ends of the girders, while the other ends are left free to slide on the top of the next column. The spans are of 33½, 41½, 43, 45 and 50 ft., with one double-track through-truss span of 161 ft., c. to c. of end pins, crossing the four tracks of the C. & N. W. Ry. and the two tracks of the P., C., C. & St. L. Ry. The greatest lift was 6½ ft., the bridge over the railway tracks being raised this amount.

The work covered about 2,650 ft., including 1,300 ft. east and 1,150 ft. west of the bridge. The grades ascending to the bridge were formerly 0.3% on the east side and 0.1% on the west, but are now 0.8% and 0.75%, respectively, the bridge being kept level at the old and new elevations. The clear headway under the bridge is 16 ft. 6 ins. No alteration in the length of the girders was required and no change has been made in the track; none of the track fastenings required tightening after the structure was raised.

To raise the structure, the columns of each bent were surrounded with vertical timbers, 10 × 10 ins., supported on sills 10 × 10 ins., and carrying cap timbers 10 × 10 ins., on which the girders rested. This framework was well braced by planks 2 × 10 ins. The arrangement is clearly shown by Fig. 1. The sills rested on jacks. At first it was intended to use screw jacks, but hydraulic jacks were found more suitable for the work, care being taken not to support the live load with these jacks. Eight jacks of 20 tons capacity were used under each frame tower at the structure bent. The nuts of the anchor bolts of the two columns were removed and the bent raised by the jacks, the pressure being transmitted to the under sides of the girders, and the bases of the columns being left free.

The raising of the structure was begun at the east and west ends and half the length on each side raised to the required grade, leaving the bridge at Rockwell St. undisturbed, and making ascending grades east and west from the bridge of 0.8% and 0.75%, respectively. After having fastened the portions so raised to the permanent work the bridge and the adjacent intermediate portions of the structure were raised, the bridge being raised by small increments, as were the other parts of the structure. The structure was raised one bent at a time, the jacks being moved from place to place as required, thus requiring only eight 20-ton jacks for raising the entire structure, except the bridge. For raising the bridge two 20-ton and two 30-ton jacks additional were required. This total of twelve jacks was necessary to raise one end of the bridge. As described by the foreman for the contractors, work was commenced about half way between the Rockwell St. bridge and California Ave., that being the extreme west end of the work. Each bent was raised about 2 ins. for three bents on each side of the center, making the change in grade at expansion joints. The jacks were then shifted to the center again, and the same operations continued, extending three panels farther out on each side. This was repeated until the span was reached at one end and the west end of the work at the other, thus giving a horizontal curve in the structure between these two points. As the structure at the west end reached the new elevation the piers were built up to this elevation in the manner described below, and the timbers thus released were transferred to the work on the east side of Rockwell St. The grade was gradually raised until the west end of the bridge had been elevated 20 ins., and the work west of that point had been about 60% completed. The timber having by this time been transferred from the completed work to the part east of Rockwell St., the same operations were continued there until the east end of the span had been raised about 30 ins., and about 75% of the new foundations had been completed. A change was then made to the west side, this operation being twice performed. It required about four days of actual working time to raise the Rockwell St. span and insert the new masonry for this span.

In order to avoid overstraining the girder connections at column points where the raising was done, no one bent was raised more than enough to make an angle (vertically) of 4 ins. in 100 ft. in the long girders of adjoining spans. This permitted usually a lift of about 2 ins. The general arrangement was to lift the structure the amount permitted by the above limitation, and insert the necessary blocking both under the columns and under the falsework; the jacks were then moved to the next bent and the operations repeated, moving back and forth over the portion to be raised until the different bents were up to grade. then the structure was supported on temporary supports while the new foundation work was being put in place. The structure was in all cases always supported on blocking resting on the old foundation, except during the building of the permanent work. At no time was any raising done under trains, nor was the structure supported on jacks while a train was passing. By this method no arrangement was necessary for controlling the

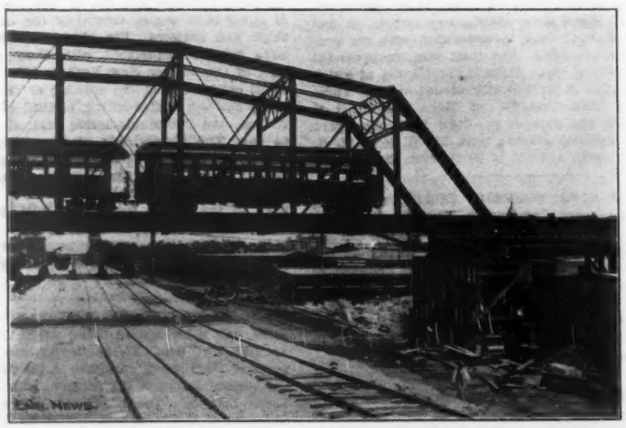


FIG. 8.—VIEW SHOWING THE RAISING OF EXPANSION END OF THE BRIDGE.
Metropolitan West Side Elevated Ry. of Chicago.

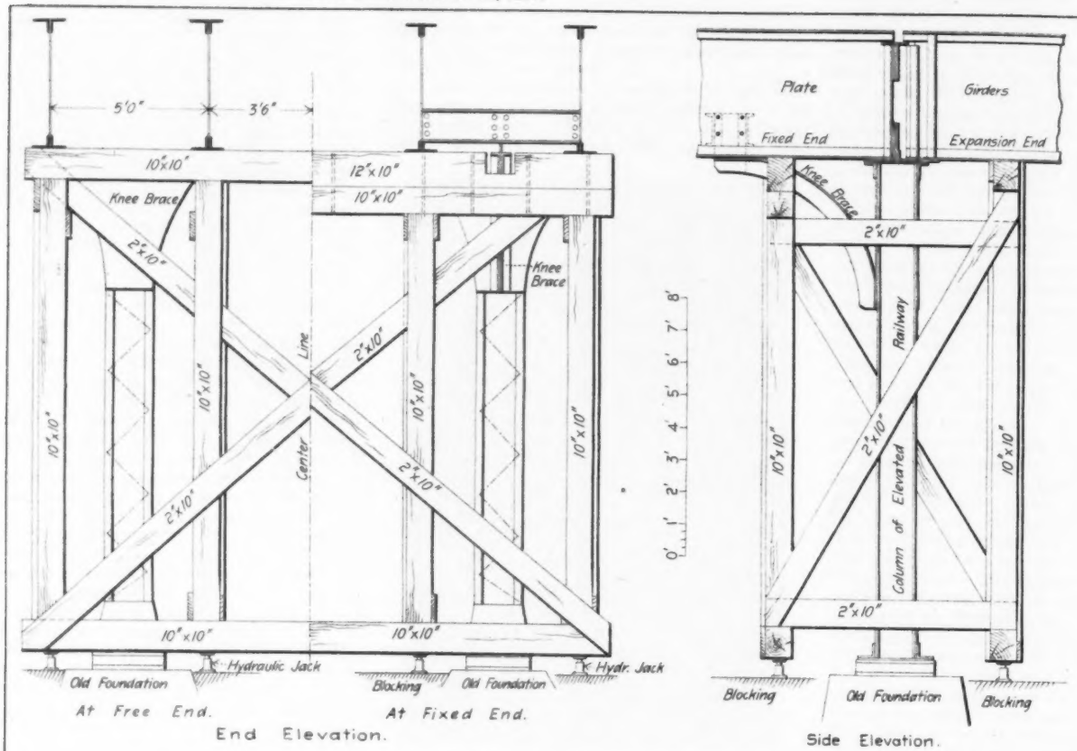
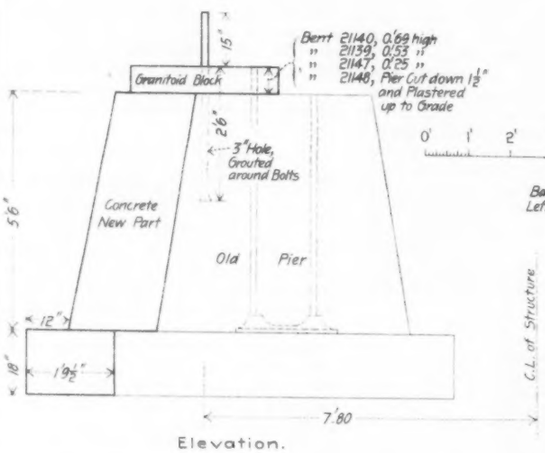


FIG. 1. FRAME WORK SUPPORTING STRUCTURE.



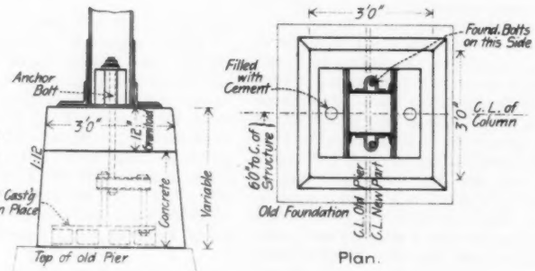


FIG. 2. OLD AND NEW CONCRETE FOUNDATIONS.

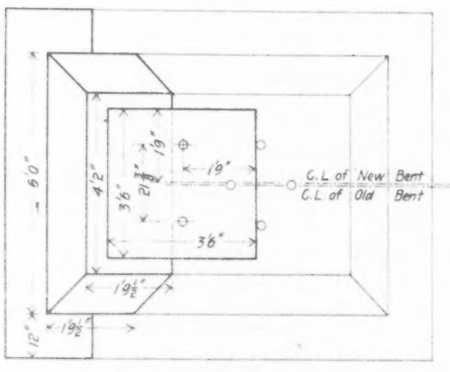


FIG. 5. CONCRETE FOUNDATION FOR SUB-BENTS.

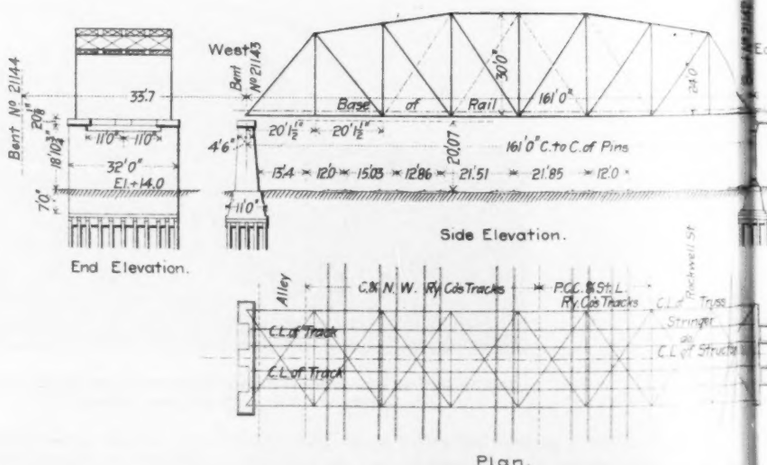


FIG. 6. TRUSS BRIDGE, 161 FT. SPAN, RAISED

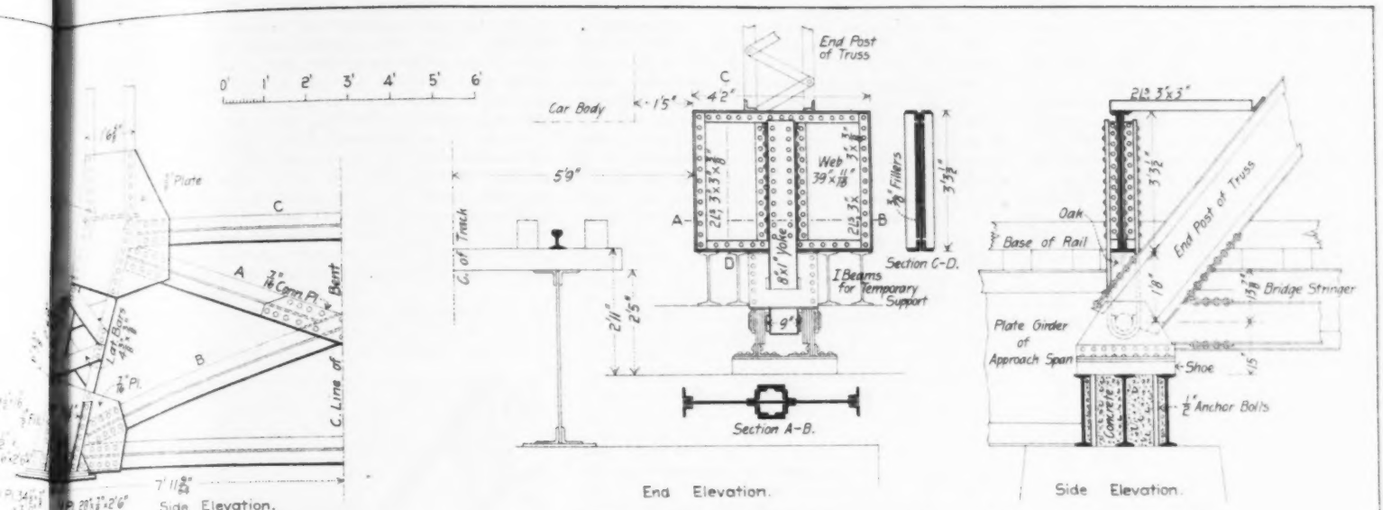
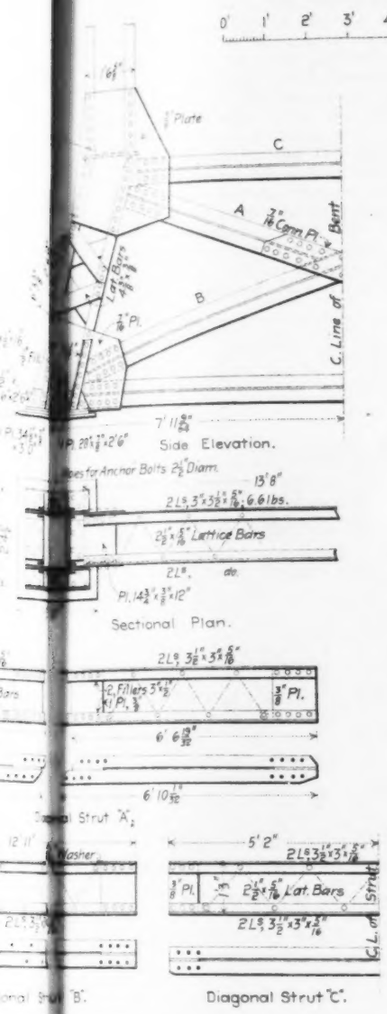
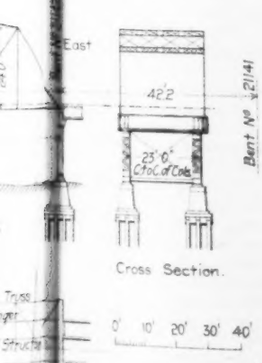
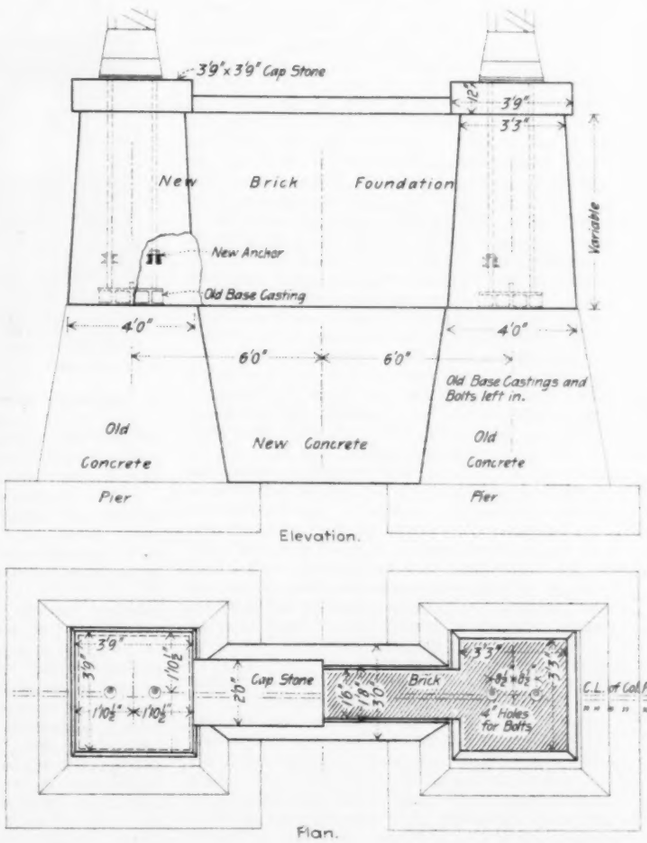


FIG. 7. HANGER FOR RAISING FIXED ENDS OF TRUSS OF 161 FT. BRIDGE.



4. STEEL SUB-BENT FOR RAISING ELEVATED RAILWAY STRUCTURE.





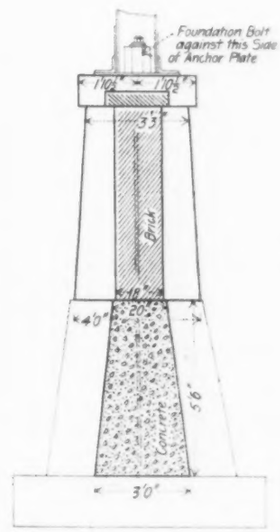


FIG. 3. NEW BRICK PIERS ON OLD CONCRETE PIERS.

RAISING THE STRUCTURE OF THE METROPOLITAN WEST SIDE ELEVATED RY., CHICAGO.

W. S. Menden, Resident Engineer.

The Kelly-Atkinson Construction Co., Contractors.

CHAS. HART & SONS, LITH., 86 VESEY ST., N. Y.

jacks so as to insure uniformity in raising, as the structure would always be let down on the blocking on the old foundation, this blocking being kept level. In raising, the workmen were required to keep the structure approximately level. The lift being small, it was impossible to distort the lateral sway girders over the columns very much. The greatest amount of lifting done in one day was 9 ft. By that is meant the sum of all lifts at the different points (bents) on the structure.

The work was all done by day and without interfering with traffic, the raising being done by very small increments, as above noted. Flagmen were kept out, and if a train was approaching the work waited until it had passed. The average time available between trains was 6 to 8 minutes, but during the busy hours this was reduced to 4 minutes.

The first and last columns were raised 1¾ ins. and 1 in., and the difference in the raise of adjacent columns was about 3 ins. in each case, varying slightly according to the span. Five different methods for maintaining the increased elevation of the structure have been employed, varying with the height of elevation, as follows:

Fig. 9.—View Showing the Raising of Fixed End of th Bridge.
Metropolitan West Side Elevated Ry. of Chicago.

1.—Placing cast-iron blocks under the columns and using longer anchor bolts to secure these blocks, as well as the bases of the columns. This method was employed at six bents for raises up to 7¾ ins.

2.—Carrying up the tops of the old concrete foundations. This was employed at 15 bents for raises from 7¾ ins. to 2.76 ft., and is shown in Fig. 2. The increased grade of the long girders would nautrally throw the columns out of perpendicular, and as the bracket connection between columns and girders proved to be extremely rigid the columns were allowed to come where they would, and a special anchor was used, consisting of a channel bolted to the old base casting (left in place), so that the anchor bolt could be shifted as required. This is shown in Figs. 2 and 3. In Fig. 2 the variation in position is 1½ ins., which was the maximum, and the new portion of the foundation was built with its center line fitted to the new position of the column, as shown.

3.—Lengthening the columns by splicing on a bottom section, or "sub-post." This was employed at only four bents, with raises of about 2.61 to 2.84 ft. Both of the spans were street crossing spans (35 ft. at Campbell Ave. and 45 ft. at Washtenaw Ave.) The old concrete piers were left undisturbed, but the base castings of the four columns at Campbell Ave. were moved 2 ins. west, and those at Washtenaw Ave. 2 ins. east, to permit of the longitudinal movement of the column bases to their new positions, enough concrete being cut out to allow of bending the anchor bolts.

4.—Building brick piers on the old concrete piers. This was employed at 23 bents for raises of 3.54 to 6.50 ft., and is shown by Fig. 3. The two old concrete piers were connected by a concrete wall 36 ins. wide at the bottom and 20 ins. at the top. These piers were 4 × 4 ft. on top, and upon them were built brick piers of varying height, about 4 ft. square at the bottom and 3 ft. 3 ins. square at the top, these piers being connected by an 18-in. brick wall. On the piers are 12-in. cap stones, 3 ft. 9 ins. square, while the wall has 6-in. coping stones, 24 ins. wide. The columns rest directly upon the cap stones, and are secured by anchors of the type described under method No. 2.

5:—Steel "sub-bents." These were employed for four bents, with raises of 5.66 to 6 ft., the two spans carried being 33 ft. 6 ins. over Cicero Court and 45 ft. between the two roadways of Congress Park. In both these cases it was undesirable to build brick piers above the ground. One of these bents is shown in Fig. 4, and consists of two inclined posts connected by top and bottom struts and by diagonal bracing. The two columns rest directly upon the top plates of the inclined posts, all angle and foot plates of the columns being cut off, and the columns drilled for being riveted to the ⅜-in. gusset plates extending above the top of the sub-bent. These bents are of steel, with ⅞-in. rivets, except that ¾-in. rivets are used in the struts. They were riveted up complete in the shops, contact faces being given one coat of paint. These bents were built by the Lassig Bridge Works, of Chicago. With these bents the feet of the inclined posts, of course, came beyond the old piers of the vertical columns. To provide for this the piers are lengthened by building up concrete against the outer faces, and capping them with granitoid blocks resting partly on the old and partly on the new concrete. This is shown in Fig. 5. The old base castings were taken out.

As already noted, the work included the raising of a double-track through truss span of 161 ft., c. to c. of end pins, weighing 200 tons. This structure is shown in Fig. 6, from which it will be seen that the west end is carried on a masonry abutment, while the east end is carried by rocker posts which form the expansion bearing. The abutment was carried up to the elevation of the bottom of the plate girders of the adjoining span, the shoes of the bridge trusses being supported on I-beams which rest on masonry. The piers of the rocking-posts were connected by concrete, and the whole pier carried up to the required grade with stone masonry. The rocker-bent was raised in the same way as the ordinary bents, but the fixed ends of the two trusses were raised by means of two hangers attached to the bridge pins, which were 4⅝ × 9 ins. A yoke of steel plate, 1 × 8 ins., was fitted to each pin, the yoke extending 4 ft. 11½ ins. above the pin. Across the yoke was riveted a heavy plate girder, 4 ft. 2 ins. long. In order to get each yoke into place some of the lacing bars and the base plate had to be cut out, and when in place it was riveted to the plate girder by eight angle-irons, forming four Z-sections, as shown in the section through the hanger. Each hanger was held in position by two angle irons, 3 × 3 ins., riveted to the end post of the truss. The hangers were supported on wooden bents, which also supported the bridge stringers and track girders of the adjoining span, the whole structure being raised together in this way and followed up with blocking on the old pier. When high enough, I-beams were inserted under the entire structure. When the spans were raised to grade the masonry was put in place under the I-beams, but blocking maintained under the I-beams wherever possible. The details of this arrangement are shown in Fig. 7.

Fig. 8 is a view showing the raising of the expansion end of the bridge. The timber framing surrounds the rocking-bent, and the caps support the transverse plate girder connecting the tops of the posts. The two diagonal or knee braces at the end of the bridge were put in temporarily to hold the rocker-bent in proper position during raising, so that it would not turn on the end pins. Fig. 9 shows the raising of the fixed end of the bridge, with the caps of the timber framework bearing against the hangers already described.

Work was commenced on May 31 and completed Aug. 1, 1897. It was all done by day, without any hindrance to traffic or injury to the workmen.

The work was designed and carried out under the supervision of Mr. W. S. Menden, Resident Engineer of the elevated railway company, and the contractors were the Kelly-Atkinson Construction Co., of Chicago. We are indebted to the engineer and the contractors for drawings and information made use of in this article.

The following is a list of the bents raised, with the amount of raise at each, the span between the bents, and the method of attaining the new elevation:

No. of Column.	Extent of Raise.	Span of Girder. Ft.	Manner of Making the Raise.
21115	0	..	.. ..
16	1¾ ins.	43	....Cast-iron blocks.
17	4¼ "	45	.... " "
18	7¾ "	41½	.... " "
19	0.88 ft.	50	....Building up concrete base.
20	1.18 "	34	.... " " " "
21	1.38 "	50	.... " " " "
22	1.68 "	50	.... " " " "
23	1.99 "	45	.... " " " "
24	2.25 "	45	.... " " " "
25	2.54 "	45	.... " " " "
26	2.80 "	45	.... " " " "
27	3.07 "	33½	....Lengthening post.
28	3.27 "	45	.... " "
29	3.54 "	45	....Brick pier.
30	3.81 "	45	.... " "
31	4.09 "	45	.... " "
32	4.36 "	50	.... " "
33	4.66 "	34	.... " "
34	4.86 "	40	.... " "
35	5.10 "	34	.... " "
36	5.30 "	50	.... " "
37	5.60 "	50	.... " "
38	5.90 "	50	.... " "
39	6.17 "	43	....Steel sub-bent.
40	6.32 "	45	.... " "
41	6.38 "	42	....Brick pier.
42	6.35 "	161	....Masonry pier.*
43†	6.35 "	33.7	....Abutment built up.
44	6.38 "	41.5	....Brick pier.
45	6.30 "	40	.... " "
46	6.14 "	45	.... " "
47	5.89 "	45	....Steel sub-bent.
48	5.58 "	45	.... " "
49	5.28 "	50	....Brick pier.
50	4.96 "	50	.... " "
51	4.64 "	40	.... " "
52	4.38 "	34	.... " "
53	4.16 "	40	.... " "
54	3.90 "	40	.... " "
55	3.65 "	40	.... " "
56	3.37 "	45	....Lengthening post.
57	3.09 "	50	.... " "
58	2.76 "	50	....Building up concrete base.
59	2.44 "	50	.... " " " "
60	2.11 "	40	.... " " " "
61	1.85 "	40	.... " " " "
62	1.59 "	50	.... " " " "
63	1.22 "	50	.... " " " "
64	0.84 "	40	.... " " " "
65	6¾ ins.	40	....Cast-iron blocks.
66	3½ "	50	.... " "
67	1 "	34	.... " "
21168	0 "	35	....

*No. 42 is the masonry pier for the rocker bent.
†No. 43 is the masonry abutment of the bridge.

THE DEVELOPMENT OF THE AMERICAN BLOOMING MILL.*

By Ralph Crooker, Jr., M. Am. Inst. M. E.†

The Bessemer and open hearth processes are the survivors of many attempts to produce a cheaper or better material than that produced by puddling. When these new methods of working iron emerged from the wholly experimental stage and became accepted commercial facts, they found the iron and steel industry already in a highly developed state. The crucible steel process was then about as perfect as it is to-day; while the making of puddled iron, stimulated to the highest degree by the building of railroads—which it had made possible—had reached a point which it has since excelled but little, if any, in quality; although for some years afterwards it continued to increase in quantity.

It was to the machinery prepared for the handling of these materials—crucible steel and wrought iron—that the first ingots of the new processes—at first almost exclusively Bessemer—came to be worked into the shapes that afforded the best market for them, or which stood most in need of such improvement in quality as they offered.

In England, where the greater part of the early development of the Bessemer was done, the ingots were at once sent to the hammer, and submitted to the same treatment as the crucible steel. I am unable to find that any attempt was made to roll it direct from the ingot during the first few years of Bessemer practice; a fortunate circumstance, I think all will agree, who are familiar with the characteristics of that early steel. The product of an English Bessemer works at this time—the middle sixties—was so small—from one to two hundred tons per week—and relatively of so little importance in the large English and continental works, that the need of

*A paper read before the Engineers' Society of Western Pennsylvania at the meeting of Sept. 21, 1897.
†Care Jones & Laughlin, Pittsburg, Pa.

machinery especially to care for it does not seem to have been felt. It was a very simple matter to add hammers as the product of the Bessemer works increased, which it did very rapidly, and this was the universal practice, persisted in until the forge department of some of the works attained tremendous proportions, one firm alone having seventy hammers in use before abandoning the system, and making little or no change except to strengthen them and increase the size from four to five, and then to seven and ten tons.

The first to undertake the improvement of this state of affairs was Mr. John Ramsbottom. He undertook to improve the hammer itself, and brought out his duplex hammer, which consisted of two hammer heads moving horizontally towards each other on rollers, the heads being actuated by a steam cylinder through links, the ingot worked upon being placed between the hammer heads, and moved in a direction at right angles with their motion. Several of these were put in operation, but they do not seem to have altogether accomplished their purpose, at least they do not seem to have suited Mr. Ramsbottom, for he shortly afterwards introduced his cogging mill, which was one of several devices brought forward at about the same time by different inventors, and the only one of them, so far as I can ascertain, which was ever put in practical use.

This mill in its general features was so nearly like the later blooming mills that one wonders how he managed to miss it. It consisted of a pair of huge housings carrying a pair of arbors, to which were bolted segments of cast iron, forming grooves which went part way round the rolls. The two rolls were made to turn in unison by means of pinions keyed to their necks and were driven, through very high gearing, by a small reversing engine. The top roll was counterbalanced by a small hydraulic cylinder in the window of the housing between the necks—an arrangement made possible by the great diameter of the rolls—over five feet—and the top roll was forced down by a wedge, driven between the top of the housing and the top box by a hydraulic cylinder, operating through a rack and pinion. The vertical movement of the top roll with this arrangement was, of course, very limited.

While Mr. Ramsbottom was busy trying to correct the faults of his duplex hammer, by building his cogging mill, others, who were using them, were wrestling with the same problem, which was forced upon them by the constantly increasing output of their Bessemer works; and the obvious methods of rolling the ingots in the "top and bottom" rolls of their rail mills was tried by several, and with considerable success. With the English rail mills it was an easy matter to do this, and it may be well here to call attention to the distinct difference in practice existing between the English and American mills of the period (1867), a difference which had come about during the preceding ten years.

Up to 1857 the mills for heavy work—those in America being nearly all rail mills—were the same in both countries, two high and non-reversing, the piece being returned over the top roll. In this year Mr. John Fritz first put in use his hanging guide, which made three-high rail mills possible, and within a few years all the American mills were made three-high. This was not the case in England, however, where efforts were made to improve their two-high mills by reversing the motion of the rolls between passes, so as to work the piece through the rolls in both directions, the means adopted being five gears and a clutch—many kinds of which were used—and later, reversing engines.

So at the latter end of the decade between 1860 and 1870 the universal practice in America was three-high and in England reversing two-high mills.

It is not surprising, therefore, that in its first blooming mills each country should have followed the form of mill prevailing at home; but so fixed was the difference of opinion as to their respective merits that each country stuck to its own, without a waver, for the next ten years, and without, seemingly, caring to know much about the other.

When it was shown that ingots could be bloomed successfully on the "top and bottom" rolls, larger reversing mills, built especially for the purpose, quickly followed, and several were in use at the end of the decade (1869-1870), although hammering was continued in some works for many years.

America did not begin its modern steel making as soon as England and Europe, nor did it advance so rapidly for some time after it began. There were several reasons for this. We were busy with a great war, which absorbed all our energies, most of our money and many lives, costs of installation and production generally were much greater, and uncertainty and dispute as to patent rights made it hazardous to enter upon such undertakings, so it was 1864 when the first ingots were made at Wyandotte, and they, like those produced abroad at the same time, were hammered. Troy, Pennsylvania, Freedom and Cleveland, the only other producers of Bessemer steel in that decade, all used the hammer for blooming.

It was at the beginning of the decade (1870-1880) when the production of Bessemer steel ingots in America had reached 40,000 tons for the year, that the shortcomings of the hammer began to be seriously felt, and the necessity of building bloooming mills forced itself upon the steel makers of this country, and the first works to put a blooming mill in operation was Troy, which rolled its first ingots in January, 1871. This mill, following the general practice of American rolling mills, was a three-high mill, being the first three-high blooming mill in the world, as well as the first blooming mill in the United States. Its top and bottom rolls were fixed, the middle roll was carried in a pair of forged steel bolsters, and was moved up or down after each pass by four screws driven from the main engine shaft by a belt, shafting and worm gearing controlled by a belt-driven reversing clutch. The tables on both sides of the rolls were raised and lowered together by hydraulic power. The top of the tables was made up of loose rollers, spaced closely, and on these the two rail ingots were pushed straight for the passes and into the rolls with bars and turned with tongs.

About six months later (July 10, 1871) the Cambria Iron Co. put in operation a mill designed by Mr. George Fritz, which had much the same influence on American blooming mills as his brother's earlier invention had had on American rail mills, and fixed the type of mill in almost exclusive use for the decade. This, also, was a three-high mill; but it differed from the Troy mill in having its middle roll stationary, while the top and bottom rolls were movable. The top roll was counterbalanced and the top and bottom rolls were moved towards the middle one between passes by screws acting together; they were, therefore, only obliged to make the full travel when opening to receive the ingot for the first pass.

The important feature, however, was the tables. These raised and lowered together by hydraulic power, and the tops were composed of rollers arranged to be driven from the main engine by gearing controlled by friction clutches. Combined with this was a manipulator, which consisted of a small car beneath the table with prongs on top of it, extending up through the table rollers when the table was down; this car was moved transversely to any desired position under the table by a hydraulic cylinder, and by lowering the ingot on to the prongs it could be turned, or by pushing the prongs against the side of the ingot it could be moved from pass to pass. This mill was a notable success.

The next year (1872) the Cleveland Rolling Mill Co. built a blooming mill which deserves mention as the first reversing blooming mill built in this country, and also because it was the only one of its type ever constructed here. It was a clutch reversing mill and all the auxiliaries, tables, shears and shear tables were driven from the train engine. As at first put down it reversed with a three-gear clutch; this was afterwards changed to the five-gear system. In both cases friction clutches were used, and I believe that no blooming mill has ever been built here that reversed with crab clutches. English practice largely influenced the design of this mill, and at that time the superiority of reversing engines was not established—although it surely was shortly afterwards; but that friction clutches were better than crab clutches for reversing was settled. The engineering periodicals and the records of engineering societies for some five or six years about 1870, are full of illustrations and discussions as to the relative merits of the many devices proposed to overcome the glaring faults of the crab, and are interesting history.

These three mills (Troy, Cambria and Cleveland) may be grouped as the pioneer American blooming mills; but only the "Fritz" mill needs further attention, the others having had no influence whatever on the design of later mills.

If the manufacture of Bessemer steel in America made slow progress in the decade 1860-1870, it quite made up for it in the first half of the next, eight large works being built on much improved plans. These were all intended for the manufacture of rails, and hardly any other outlet for their product was looked for or expected, the power of new railroad enterprises to absorb the product seeming, at the time, to be almost limitless, while the inferior quality of much of the early steel still cast a deep shadow of suspicion on its reliability for other purposes.

For blooming ingots, of the size then made for rails, it was, and is still, difficult to improve on the Fritz mill; the size of the ingots not requiring excessive length of tables, and the large section of the finished bloom made it possible to do the work on short rolls of comparatively small diameter. Under these conditions it is easy to understand why nearly all of these eight works, built between 1871 and 1876, put in "Fritz" blooming mills, and no other kind of mill had a trial until these conditions changed. As these mills followed each other in rapid succession, each was an attempt to improve upon its predecessors; but the improvements were entirely confined to minor details. Driving the tables by independent power succeeded various methods of driving from the main engines, operating the table rollers automatically by V friction wheels, engaging when the tables were in either the highest or lowest position, came into use and was followed by a positive drive by means of gears, lazy togs and reversing engines; the rolls, however, continued to be movable.

The great expansion of the Bessemer steel rail business between 1871 and 1876 was followed by an equally great depression in consequence of the business panic of 1873, and during the last half of the decade very little was done in new Bessemer construction, the efforts of the steel makers being entirely directed towards economical production, and it was these efforts which led to the first departure from what had come to be distinctly recognized as the American blooming mill.

The familiar method of increasing the tonnage of the one almost universally adopted to bring about the desired result, and so successful were the managers of the converting departments in this direction that the product of vessels soon exceeded the capacity of the casting pits to handle it, planned, as they had been, for the work of some years earlier.

Faced with this state of affairs the Cambria Iron Co. in 1875, determined on a radical departure from the prevailing pit practice, which involved the making of ingots much larger than those in common use, and to care for these they put in a mill which deserves attention, being the first blooming mill in the country reversing with engines, and unique in other respects.

When the "Freedom" works was built in 1868 a plate mill had been imported from England with a reversing engine, said at the time to be "the best of its class yet produced." It was this mill and engine, with blooming rolls substituted for the original plate rolls, which the Cambria Iron Co. utilized to work the large ingots. It was, therefore, an English mill; but the tables, which constituted its chief title to distinction, were American, having been designed by the late Mr. Daniel N. Jones. These consisted of large rectangular frames carrying the gudgeons of loose rollers, the bodies of which rested on solid tracks. These frames, with the rollers, were moved to and from the rolls, through a short distance, by hydraulic cylinders. It will thus be seen that when the table, with the ingot resting on the rollers, was pushed by the cylinder towards the mill, the ingot, moving twice as fast, was projected over the end of the table and into the rolls. With this table was combined a manipulator which was very simple and efficient. It consisted of two hydraulic cylinders; one mounted on each side of the table, but independent of it, with the piston rods extending over it and carrying heads so shaped that by forcing them against the ingot it could be turned or moved from one pass to another. A useful feature of this manipulator was that by stopping the mill with the piece in the rolls a crooked bloom could be straightened by forcing one of the heads against it, an important advantage when ingots have been unevenly heated. The screws of this mill were operated by a small steam engine, and the top roll was counterbalanced by hydraulic pressure. It is a singular fact in connection with this mill, with a manipulator in successful use, that none of the numerous reversing mills built were equipped with manipulators of any kind for seven years afterwards.

While the blooming mills built up to this time had all been in connection with Bessemer works and with a view to rail manufacture, the open hearth process had been steadily developed since 1870, and it is to be noted that from the time when the building of Bessemer works ceased in 1875 until the phenomenal development of new undertakings following the business revival of 1879-80, the building of open hearths was about the only new work done, and the product was at first almost as exclusively devoted to plates as the Bessemer was to rails. The hard times of the last half of the decade forced the Bessemer makers to try to dispose of a part of their steel by rolling their blooms into billets on other mills; at the same time the high quality of the open hearth metal had created a considerable demand for it; but the open hearth makers labored under great disadvantages in getting their material into marketable shape, being compelled to cast small ingots and roll them on the larger bar mills. The Fritz patents had passed into the hands of an exclusive corporation, and the small size of the open hearth works, coupled with the high cost of a blooming mill, made the open hearth people hesitate before putting in so much capital to do so little work.

At last, in 1879, Shoenberger & Co. put in operation a reversing blooming mill, in connection with their open-hearth furnaces, which was the first to be built except at a Bessemer plant, and also the first to be devoted entirely to the general trade in blooms, billets and slabs. In this mill the grooves in the rolls were of varying depth, the screws were worked by power from the shears engine through a "Hill" clutch, and the tables, made of I-beam frames and cast-iron rollers, were driven and reversed by the train engine direct, through belts. The rolls were driven by a pair of reversing engines which had previously been used on a gunboat, no reversing rolling mill engines having then been made in this country. This mill is of interest, as the experience gained from it was embodied in the design of the one erected at Homestead two years later, thus having a decided bearing on the development of our modern mills, and, furthermore, because on it were made the first 4-in. billets rolled direct on a blooming mill.

The same reasons which led to the building of the Shoenberger mill caused other open hearth makers to do the same; but so firmly fixed was the superiority of the three-high mill over the reversing mill, in most minds, that the latter received but little consideration. To use

three-high mills, however, the Fritz patents must be avoided, and with this object in view two mills were built—one for Naylor & Co. for billets, and one for the Springfield Iron Co. for rail blooms. The peculiarity of these mills was the table arrangement. At the back of the rolls was a table of loose rollers, lifted directly by a jack; on the front side were ordinary hooks which were raised and lowered by the motion of the back table, but through less distance. A fixed driven roller was placed over the back table in such a way that when the table was raised the ingot was forced against it and thus carried into the rolls.

Another mill should here be spoken of as illustrating the expedients to which steel works managers resorted when the Fritz patents could not be used and before mills reversing with engines were accepted as good practice in this country. It was put in at the Union Works at about the beginning of 1880 and was reversed by the surface friction of large wheels with very broad faces (20 ft., and 8 ft. in diameter, I think) which were forced in contact by means of a hydraulic cylinder and levers. This mill was afterwards replaced by a modern three-high mill, and should be remembered only as taking the place of the last hammers in the business, and as being the last attempt at reversing in any other way than by engines.

With the beginnning of the decade 1880–1890 came great changes in the business conditions affecting the steel industry, and these were quickly reflected in repairs, improvements and additions to existing plants and the starting of new enterprises. The tremendous business expansion which began late in 1879 continued through 1880-81 and 1882, and the demand for steel works products, especially rails, was unprecedented. This demand came upon works, many of which, during the preceding five years, had been run with the least possible expenditure for repairs, and were now driven to the utmost capacity. This usage of machinery quickly made necessary the replacement of several of the earlier blooming mills, while some firms added complete new plants.

In these renewals and extensions the influence of the Cambria practice of large ingots is clearly shown, all the new mills being made larger and stronger, while two mills, a three-high at Bethlehem about 1884, and a reversing mill at Cambria in 1885, following the decided tendency of the time, were made 40 ins. in diameter. The conclusion seems to have been reached, however, that equally good results may be obtained from somewhat smaller mills, and none have since been set up of over 40 ins.

With this group of new mills the three-high mill reached a fixed standard which we may call the modern three-high blooming mill, the first one embodying all its characteristics, having been put down at Chattanooga in 1878, and since this time no appreciable change has taken place. In these mills the rolls are all fixed, the tables are raised and lowered by a horizontal cylinder connected with L cranks and links, and the table rollers are driven by an independent reversing engine through gears carried by a lazy tongs. How thoroughly efficient this kind of mill has proved itself for the making of rail blooms is shown by the fact that in all the new work intended for rail-making, in the decade which we are now considering, all but two were of this description—one at Scranton and the other at the Cambria Works. In this latter case the necessity of making various sizes for other purposes than rails largely governed the choice, and it is of interest that this mill replaced the original Fritz mill.

Of the many new enterprises inaugurated during this period, the works erected at Homestead in 1881 by the Pittsburg Bessemer Steel Co. from the plans of Mr. James Hemphill claims particular attention. This plant, the beginnning of the great establishment now located there, was the first Bessemer works especially built to manufacture steel for other purposes than rails; it was also the first to be put in operation after the expiration of the essential Bessemer patent, and in its construction a number of patents, supposed by many to be indispensable, had to be avoided.

In designing the blooming mill the experience gained in the "Shoenberger" mill—alluded to earlier in this paper—was largely availed of, and several features afterwards generally used in American reversing blooming mills were introduced. The mill was driven by the first American reversing engine intended for rolling mill use; the rolls were made with all the grooves of equal depth, thus permitting the adoption of straight table rollers and the making of any sizes on one pair of rolls, and the roll screws were worked by a hydraulic cylinder through a rack and multiplying gear. The tables were constructed with I-beam frames and the table rollers were driven by an independent reversing engine, the ingot being handled and turned on the tables by ordinary hooks hung from above, and tongs.

This mill proved itself very efficient, and during the following years many mills of similar character were built, the building of blooming mills receiving great impetus by reason of the change of the material used in cut nails from iron to steel and by the increasing demand for Bessemer billets, which followed rapidly when once they were fairly on the market. In these mills, about the only changes from the Homestead mill was the substitution of heavy cast iron table frames for the I-beam construction, and a simplifying of the table driving gearing. It was on one of these mills, at the Spang Steel Works in 1885, that the first manipulator after the Cambria one of 1878 was tried, and after that they came slowly into use.

Another mill, which should be mentioned in connection with the new enterprises of this time, is one which was put to work at Scranton for making rail blooms, in 1883. This mill, with its engine, was imported from England, and is the only complete mill ever brought from there. It was a good sample of the typical English mill of the time; very heavy and with great power. The tables consisted of loose rollers, their necks running freely on rails, and the ingots were handled on these with tongs. This table arrangement, which was never copied by American mills, was replaced some years later by a modern driven roller table. This mill seems to have had some influence in calling attention to what could be done by increasing the engine power of our mills, which was emphasized later by the work of the Sparrow's Point mill.

With the decreasing requirements for rails in this decade, and the ever-increasing demand for steel for other purposes, the three-high mill, except for replacements in rail works, received but little attention. It seemed to be accepted as fact, that the two-high mill was best where a wide range of work was to be done. It is for this reason that a mill put down at the Otis Works, at Cleveland, to combine the advantages of both systems, requires description, being the last of the modifications of the three-high mill. In this mill the bottom roll was fixed, the top roll was counterbalanced and worked with screws in the same manner as the top roll of a two-high mill, while the middle roll was thrown up and down between passes as in a three-high plate mill; the collars being made extra wide, to support the middle roll which rested against them when working. The Fritz tables of this mill were 30 ft. long, and the only ones of that type ever fitted to a mill for general bloom and billet work.

With the beginning of the present decade practice had become so established that but one mill may be considered as particularly departing from it. This is the Sparrow's Point mill, which is the only thoroughly American reversing mill which has yet been intended exclusively for rail blooms, and is noticeable chiefly for the great power of its engines, which demonstrated the capacity of this form of mill when properly engined; and since the installation there has been a marked increase in the power provided for mills of its class.

The three-high blooming mill reached its highest development at about the time when the two-high mill began its career, and within ten years of its inception; and since that time their number has diminished rather than increased, partly because of a reduction in the number of rail-making establishments, in which field it has maintained its pre-eminence, and shows how thoroughly adapted it was to the purpose for which it was intended.

With the two-high mill it is a story of progressive development for nearly twenty years. We did not begin with this kind of mills until it had been in use abroad for many years, but we availed ourselves little of foreign experience and followed lines of our own, improving and altering our original designs. The first table-frames made of I-beams were displaced by cast iron with the bearings cast on; these were followed by built up wrought-iron and cast-iron frames with separate bearings; the present table frame being a substantial cast-iron bed plate with the bearings bolted on, and in some instances water cooled.

Table rollers of cast iron with wrought axles cast in were quickly abandoned for the wrought-iron pipe roller in general use on the three-high mills; then came the steel casting with the necks cast on, and to-day the preference is divided between these and a roller made of a cast-iron body fitted with a forged axle. The driving of the table rollers began by taking power from the main engine, which was soon changed to the use of a separate engine driving both tables together through a countershaft; and finally the countershaft has been done away with, an engine coupled directly to the line shaft being used for each table. At the same time there has been a steady improvement in the table gearing. In the earlier mills the rollers were divided into groups driven by spurs and idlers; the number of these has been gradually reduced until each separate roller is now driven by a miter gear, and there is not a single intermediate gear or countershaft of any kind in the best mills.

Manipulators, after a few trials, superseded the old-fashioned hooks and tongs, and since 1880 have been in general use. In this matter alone there seems still to be a difference of opinion, and some half dozen kinds have their advocates.

In the mill itself, we have finally widened the windows of the housings so that the rolls may be changed through them; and we now generally use hydraulic counterbalancing for the top roll—methods which have prevailed in other countries from the beginning, but which we reached rather by evolution than by imitation. For working the roll screws there has been but slight change since hydraulic power took the place of belts and engines, although electric motors are used on some mills requiring extraordinary lift to the top roll. The early mills were driven by engines with gearing of three or four to one; these ratios have been steadily cut down until gearing has been abandoned, and the latest mills are connected directly to the crank shaft.

It seems as though the work of simplifying the two-high mill has about reached its limit, and, like the three-high mill of fifteen years ago, there is little room left for further improvement.

Fig. 1.—Cart in Dumped Position.

Fig. 2.—View of Levers Operating Tail Board.

AN ALL METAL DUMP CART FOR CONTRACTORS.
Kansas City Wheel Scraper Co., Kansas City, Mo., Builders.

AN ALL-METAL DUMP CART FOR CONTRACTORS' USE.

We illustrate herewith a dump cart constructed entirely of metal, except the wheels, which is being put on the market by the Kansas City Wheel Scraper Co., of Kansas City, Mo. Fig. 1 is a general view of the cart in the dumped position, and Fig. 2 shows the mechanism for operating the tail-board in more detail. The box of the cart is attached directly to the axle and has a dumping angle of about 45°. Its capacity is 22 cu. ft. When level the height of the top of the box is 44 ins., or about breast high, and it is held in the level position by the spring hook shown attached to the foot-board. The operation of the tail-board is clearly shown by the drawings, and, as will be seen, is automatic. Inside, the box is free from projections, and it is therefore easily dumped clean. The shafts are of gas pipe, with wooden plugs driven into the back ends about 3 ft. The manufacturers state that these carts weigh less than a wooden cart of the same capacity, and are as cheap as, or cheaper than, wooden carts, while their durability is much greater.

TEST OF A 30,000,000-GALLON PUMPING ENGINE AT BUFFALO, N. Y.

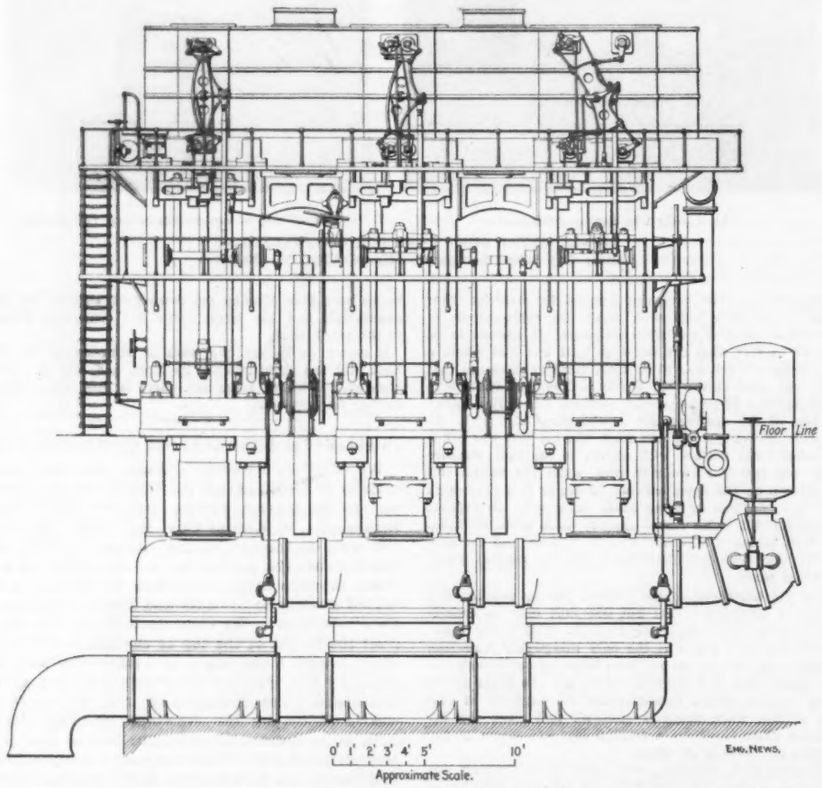
The accompanying illustration is a front elevation of a 30,000,000-gallon vertical triple-expansion pumping engine, built last year by the Lake Erie Engineering Works, Buffalo, N. Y., for the Buffalo City Water Works. It is remarkable not only for the high duty obtained on the official test, viz., 152,041,166 ft. lbs. per 1,000 lbs. of steam, but also for the short time in which it was built, believed to be the shortest time on record for so large an engine.

The contract for the engine was awarded Oct. 11, 1895, and it required that the engine should be completed and ready for operation in 150 days from that date. On March 9th, 1896, at the expiration of the 150 days, the contractor notified the Comisssioners of Public Works that the engine was ready for service, but owing to the conduits, boilers and discharge pipes and main delivery pipes not being completed the engine was

not started until July 4, 1896. This run was only for a short time with temporary connections and boilers. The main delivery pipes were not completed until the middle of December, so that the capacity and duty trial were not made until December 23.

When the order was received the engine had to be designed and general and detail drawings made, as well as all patterns, so that the engine was designed, built and erected on its foundations ready for steam in 150 days. Rival bidders for the work had stated at a hearing before the Water Board that the engine could not be built and erected in less than twelve months, and that there was no concern in America that could do it in six months.

The city specification required that the engine should be capable of pumping 30,000,000 U. S. gallons of water in 24 hours, against a head equivalent to 200 feet above the level of the water in the inlet well, and should give a duty of



TRIPLE-EXPANSION PUMPING ENGINE, 30,000,000 GALLONS CAPACITY, AT THE BUFFALO, N. Y., CITY WATER-WORKS.

Built by the Lake Erie Engineering Works, Buffalo, N. Y.

130,000,000 ft. lbs. per 1,000 lbs. of steam; the contractor to forfeit $1,000 for every million or fraction thereof below the 130,000,000, and to pay a forfeit of $50 per day for every day that the engine was not completed and ready for operation after 150 days.

The contractors agreed to build an engine to fill the requirements, and guaranteed 140,000,000 ft. lbs. per 1,000 lbs. of steam, with a forfeiture of $1,000 for every million or fraction thereof below the 140,000,000.

The engine is of the vertical, triple expansion, crank and fly wheel type, with the steam cylinder barrels jacketed and with two reheating receivers. The high pressure cylinder jackets and the two reheaters are supplied with steam at boiler pressure. The intermediate and low pressure jackets take steam at reduced pressures. The cylinder heads are not jacketed, owing to the valves being incorporated in them. The pumps take their suction from a well, supplied by a conduit connected with the tunnel. The discharge from the pumps is delivered into a 48-in. main, which connects with two 36-in. mains, one running to the city distributing system, and the other to the reservoir.

The pumps consist of three single acting, outside packed plungers, 42 ins. diameter, 5 ft. stroke, located directly under the steam cylinders. During the tests the average distance from the delivery valve deck to the water in the pump well was 5 ft.

There are in each suction and discharge chamber 208 valves, each 4¾ ins. diameter.

The air pump is single acting and is driven from an arm projecting from the low pressure cross head. The air pump cylinder is 33 ins. diameter and 5 ft. stroke. The diameters of the steam cylinders are respectively 37, 63 and 94 ins. There are two piston rods to each cylinder, 5 ins. diameter. The clearances in the three cylinders are respectively 1.42, 1.22 and 1.02%.

The cut-offs on the cylinders are adjustable up to any desired point. The cut-off of the high pressure cylinder is under the control of a governor which regulates the speed after it reaches a certain limit.

The condenser is of the jet type, and the injection water is taken from the suction chamber. There is also a 3-in. connection from the delivery main to the condenser, to be used as a force injection when required.

The official duty test was made by Mr. Newcomb Carlton and Mr. Geo. H. Barrus, M. Am. Soc. M. E. We quote from their report as follows:

The duty trials were conducted, as far as possible, according to the methods recommended by the Duty Trial Committee of the American Society of Mechanical Engineers.

The method adopted to determine the amount of water delivered, was that of measuring by the plunger displacement. The amount of slip in pumps of this design is extremely small and the quantity computed from the plunger displacement may be taken, for all practical purposes, as the amount delivered.

During the capacity tests the piston speed was maintained at about the requirements of the specification, and no effort was made to run the engine up to its maximum capacity.

Two duty trials were made: 1. A preliminary trial on the reservoir service under an average head of 134.6 ft., called the reservoir trial.

2. The main duty trial under an average head of 199.19 ft., representing the head due to pumping direct into the mains supplying a part of the city, and called the high service trial.

The reservoir trial was made under the regular working conditions of the engine, at the request of the Commissioners of Public Works, in order that the economy of the engine under reservoir service might be known.

The high service trial was made to determine the fulfilment of the contract. Efforts were made while the engine was running on reservoir service to realize a head of 200 ft. by throttling the mains leading to the reservoir. These attempts being unsuccessful, the engines connected with the high service mains, the engines supplying them stopped, and after a short preliminary run the test was started in the early morning of Dec. 24, 1896.

The pressure being somewhat below the requirements of the specification, a 15,000,000-gallon engine, delivering into the high service mains, was started at a low rate of speed, which speed was gradually increased until the working pressure in the mains had reached a pressure equivalent to a head of about 200 ft.

The principal data and results of the high service trial are as follows:

Duration of trial	12 hours
Dry steam consumed per hour	14,694.8 lbs.
HP. developed by high pressure cylinders	396.02 HP.
" " by intermediate cylinder	302.62 "
" " by low pressure cylinder	496.82 "
" " by whole engine	1,185.5 "
Average pressure in steam pipe	107.1 lbs.
" " in first receiver	38.6 "
" " in second receiver	2.2 "
" vacuum in condenser	27.18 ins.
" revolutions per minute	20.77
Mean effective pressure in high pressure cylinder	58.4 lbs.
Mean effective pressure in intermediate cylinder	15.3 "
Mean effective pressure in low pressure cylinder	11.4 "
Dry steam consumed per I. HP., per hour	12.39 "
Dry steam consumed per I. HP. per hr. by jackets and reheaters	1.69 "
Percentage of total steam condensed in jackets and reheater coils	13.7%
Dry steam consumed per I. HP., per hr, exclusive of jacket and reheater steam	10.7 lbs.
Heat consumed per I. HP. per hour	13,842.2 B. T. U.
Temperature of feed water	100.6° F.
Total head, 199.19 ft. =	86.145 lbs.

Duty Trial, High Service.

Duty based on 1,000 lbs. of dry steam	152,041,166 ft. lbs.
Duty based on 1,000,000 heat units	135,403,745 "
Capacity or number of gallons discharged in 24 hrs. at average piston speed of 207.67 ft. per min.	33,261,720 gallons

Measurements and Computations Based on Indicator Diagrams.

	Cylinders, H.p.	Int.	L. p.
Initial press. above atmosphere, lbs.	158.03	38.87	4.97
Cutoff press. above zero, lbs.	166.9	45.5	16.0
Release pressure above zero, lbs.	51.7	16.3	7.4
Compression press. above zero, lbs.	50.50	16.30	2.05
Back press. at mid stroke above or below atmosphere, lbs.	39.5	4.9	−12.5
Mean effective pressure, lbs.	60.66	15.04	12.37
Proportion of forward stroke:			
Completed at cutoff	0.323	0.376	0.483
Completed at release	1.0	1.0	1.0
Proportion of return stroke uncompleted at compression	.0245	.0302	.0232
Steam accounted for at cutoff, lbs.	9.1	8.86	9.74
Steam accounted for at release, lbs.	8.98	8.8	9.66
Proportion of steam consumed exclusive of jacket and reheater steam accounted for at cutoff	.850	.828	.912
Proportion of steam consumed exclusive of jacket and reheater steam accounted for at release	.704	.774	.851
HP. computed from press. indicated by force and suction main gages	1,128.4 HP.		
HP. absorbed in friction	57.1 "		
Percentage of friction	5.06%		

Reservoir Trial.

Steam pressure ta the throttle	128.9 lbs.
Temperature of feed water	103.6° F.
Total head, 134.6 ft. =	58.24 lbs.
Duration of trial	12 hours
Duty based on 1,000 lbs. dry steam	147,209,362

PROGRESS OF WORK ON THE CHICAGO DRAINAGE CANAL.

At a meeting of the Board of Trustees of the Sanitary District of Chicago, on September 22, a report was submitted by Mr. Isham Randolph, Chief Engineer, showing that 95% of the main channel excavation has now been completed, and this report was accompanied by a table which we give below, showing the amount of work done up to Sept. 1 on each of the several contracts, and the amount of work yet remaining to be done. It will be seen that the amount yet to be done on the main channel comprises about 1,768,553 cu. yds. of glacial drift excavation, 147,166 cu. yds. of solid rock excavation, 266 cu. yds. of retaining wall, and 6,636 cu. yds. of masonry. There are four

CHICAGO MAIN DRAINAGE CANAL.—STATEMENT SHOWING CONDITION OF CONSTRUCTION CONTRACTS ON SEPT. 1, 1897.

Designation.	Amount done during August, 1897. Main channel. Glacial drift. cu. yds.	Solid rock. cu. yds.	Ret'g wall. c. yds.	Masonry. c. yds.	Total done to Sept. 1, 1897. Main channel. Glacial drift, cu. yds.	Solid rock, cu. yds.	Retaining wall, cu. yds.	River divers'n. Glacial drift, cu. yds.	Solid rock, cu. yds.	Masonry, cu. yds.	Estimated remaining to be done. Main channel. Glacial drift, cu. yds.	Solid rock. cu. yds.	Retaining wall. cu. yds.	Masonry. cu. yds.	Percentage completed. Main channel excavation.	River Div. excavation.	Masonry.
Chicago River improvement..	5,150	.....	.....	.....	32,660	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
B.....	48,324	.....	.....	.....	1,268,096	.....	.....	.....	.....	.....	380,649	.....	.....	.....	76.91	.....	.....
N.....	45,744	.....	.....	.....	527,422	.....	.....	.....	.....	.....	586,421	.....	.....	.....	47.35	.....	.....
M.....	.....	.....	.....	.....	728,189	.....	.....	.....	.....	.....	.....	.....	.....	.....	100.00	.....	.....
L.....	.....	.....	.....	.....	1,102,980	.....	.....	.....	.....	.....	4,159	.....	.....	.....	99.62	.....	.....
K.....	.....	.....	.....	.....	1,149,031	.....	.....	.....	.....	.....	31,553	.....	.....	.....	97.33	.....	.....
I.....	.....	.....	.....	.....	1,159,384	.....	.....	.....	.....	.....	.....	.....	.....	.....	100.00	.....	.....
H.....	.....	.....	.....	.....	964,070	.....	.....	.....	.....	.....	98,142	.....	.....	.....	91.04	.....	.....
G.....	.....	.....	.....	.....	1,323,000	.....	.....	.....	.....	.....	40,741	.....	.....	.....	97.01	.....	.....
F.....	27,474	.....	.....	.....	936,808	.....	.....	179,447	.....	.....	151,301	16,724	.....	.....	84.79	100.00	.....
E.....	28,535	630	.....	.....	1,470,719	630	.....	95,718	.....	.....	346,111	78,135	.....	.....	77.02	100.00	.....
D.....	2,125	9,293	.....	.....	1,914,912	85,240	.....	.....	.....	.....	.....	14,760	.....	.....	99.27	.....	.....
C.....	15,400	.....	.....	.....	1,859,463	.....	.....	162,537	.....	.....	44,993	.....	.....	.....	97.61	100.00	.....
B.....	.....	.....	.....	.....	1,548,114	14,900	.....	212,486	.....	.....	886	100	.....	.....	99.94	100.00	.....
A.....	25,400	2,390	.....	.....	2,511,875	12,800	.....	359,353	.....	.....	59,033	.....	.....	.....	97.72	100.00	.....
1.....	8,500	11,000	240.0	.....	1,280,066	535,700	67,900	174,655	.....	.....	2,465	17,305	266	.....	98.91	100.00	90.31
2.....	.....	.....	.....	.....	724,905	483,750	38,506	119,234	.....	.....	.....	.....	.....	.....	100.00	100.00	100.00
3.....	.....	.....	.....	.....	425,705	760,718	14,039	.....	.....	.....	.....	.....	.....	.....	100.00	.....	100.00
4.....	.....	.....	.....	.....	1,096,746	262,428	68,169	106,803	17,857	.....	.....	.....	.....	.....	100.00	100.00	100.00
5.....	.....	.....	.....	.....	952,526	378,699	56,969.1	12,256	.....	.....	.....	.....	.....	.....	100.00	100.00	100.00
6.....	.....	.....	.....	.....	683,248	549,355	30,361.7	118,647	.....	.....	.....	.....	.....	.....	100.00	100.00	100.00
7.....	.....	.....	.....	.....	181,721	880,939	6,179.9	97,917	43,102	.....	.....	.....	.....	.....	100.00	100.00	100.00
8.....	.....	.....	.....	.....	50,170	1,141,252.1	2,874.9	57,902	99,399	.....	.....	19,782	.....	.....	98.37	100.00	100.00
9.....	.....	.....	.....	.....	76,692	1,005,739	.....	40,763	16,873	.....	.....	.....	.....	.....	100.00	100.00	.....
10.....	.....	.....	.....	.....	31,743	1,141,890	.....	30,313	58,276	.....	.....	.....	.....	.....	100.00	100.00	.....
11.....	.....	.....	.....	.....	44,021	980,711	.....	12,699	15,677	.....	.....	.....	.....	.....	100.00	100.00	.....
12.....	.....	.....	.....	.....	44,030	998,709	9,286.94	11,739	7,475	.....	.....	.....	.....	.....	100.00	100.00	100.00
13.....	.....	.....	.....	.....	33,810	1,033,665	10,838	.....	.....	.....	.....	.....	.....	.....	100.00	.....	100.00
14.....	.....	371	367.8	.....	380,165	1,022,796	23,567.8	.....	.....	.....	.....	.....	.....	.....	100.00	100.00	100.00
15.....	.....	.....	.....	.....	35,324	647,039	44,811.2	619	.....	.....	.....	.....	.....	.....	100.00	100.00	100.00
Disposal works at Lockport...	.....	3,300	.....	1,851	.....	7,238	.....	.....	.....	3,091	.....	272	...	6,636	96.37	.....	31.78
Abandond fixd bdgs over M.C.	.....	.....	.....	.....	1,289	.....	.....	.....	.....	.....	22,099	.....	...	.....	5.51	.....	.....
A.,T. & S.F. Ry. Bridge,Sec. G	12,731	.....	.....	.....	12,731	.....	.....	.....	.....	.....	.....	.....	...	.....	.....	.....	.....
E., J. & E. Ry. Bridge	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,041.84	.....	.....	...	.....	.....	.....	100.00
Total	219,383	26,894	607.8	1,851	24,561,606	11,961198.1	372,593.54	1,793,088	258,659	4,132.84	1,768,553	147,106	266	6,636	95.02	100.00	99.93[2] 38.38[3]

[1]Estimated amount indefinite. [2]Retaining wall, 99.93%. [3]Masonry, 38.38%.

sections of the main channel yet uncompleted, as follows:

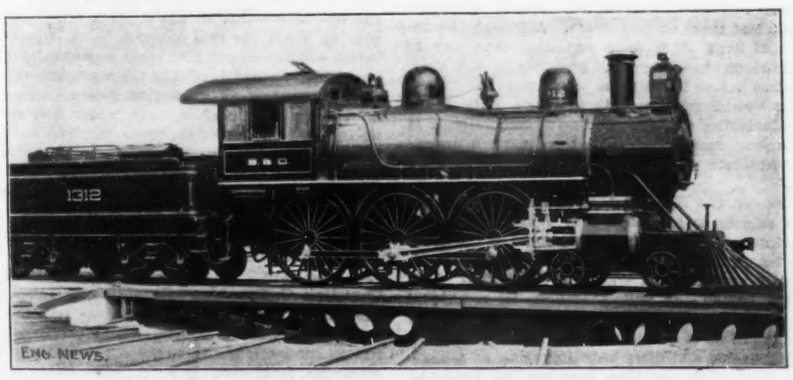
Section E, 55% completed, six months' more work.

Section F, 75% completed, and the contractors claim they could finish the balance in 60 days if the Trustees would secure for them the necessary right of way. This section will probably not be finished before June, 1898.

Section N (dredge work), 50% finished. Work will not be completed before June, 1898.

Section O, 75% of the work done, four more months' work.

When these sections are finished the main channel will be completed from Robey St., Chicago, to Lockport, but, besides this, there is the extension to Joliet, and the engineer estimates that this will take at least 15 months to complete. There is, however, no certainty as to when the work can be commenced, owing to delays in the Courts, though condemnation proceedings are now pending. It is estimated that the dredging of the Chicago River made necessary to secure the required flow of 300,000 cu. ft. of water per minute through the main river, will be finished by November, 1898. The total expenditures of the Board of Trustees up to September 1, 1897 (for nearly 8 years), amounted to $18,172,094, and it is estimated that the work yet to be done will cost over $8,000,000, this work including the channel at Joliet, pumping works for the North Branch of the Chicago River, the channel from Lake Calumet, the diversion of the flood waters of the Calumet River, the 39th Street conduit, etc.



TEN-WHEEL EXPRESS LOCOMOTIVE; BALTIMORE & OHIO R. R.
Baldwin Locomotive Works, Builders.

TEN-WHEEL EXPRESS LOCOMOTIVE; BALTIMORE & OHIO R. R.

The use of engines of the ten-wheel type for fast passenger service has been growing very rapidly with the last few years, and the new equipment of the Baltimore & Ohio R. R. includes some fine engines of this type. A noticeable feature in these engines is that they are intended to burn coke for fuel, a practice which, from its insurance against smoke and cinders, cannot but be acceptable to the passengers. The boiler is of the extended wagon-top type, having the dome and the mounting for safety valves and whistles on the wagon top. Double-bar guides are used and the connecting and side rods are of I section. The engines were built by the Baldwin Locomotive Works, of Philadelphia, Pa., and we are indebted to the builders for photographs and particulars of the engines. The leading dimensions and particulars are given below in our standard form:

Ten-Wheel Express Locomotive; Baltimore & Ohio R. R.

Running Gear:	
Driving wheels, diameter	6 ft. 6 ins.
Truck wheels, diameter	2 " 9 "
Tender wheels, diameter	3 " 0 "
Engine truck	Swing center.
Journals, driving axles	8 × 8 ins.
" truck axles	5 × 10 "
" tender axles	4¼ × 8 "
Wheelbase:	
Driving	13 ft. 8 "
Truck	6 " 0 "
Total engine	24 " 6 "
" tender	17 " 0 "
" engine and tender	51 " 7 "
Truck pin to center of leading driving axle..	7 "10 "
Wheels having blind tires	Second pair.
Weight in Working Order:	
On driving wheels	112,800 lbs.
On truck wheels	33,600 "
Engine, total	146,400 "
Tender, total	80,000 "
Engine and tender, loaded	226,400 "
Tender, empty	40,420 "
Of full coal capacity	7,244 "
Of full water capacity of tank	32,336 "
Allowed for water in boiler	15,000 "
Cylinders	21 ×26 ins.
Distance center to center	7 ft. 3 "
" center to valve face	1 " 6½ "
Piston rod, diameter	3½ "
Form of crosshead and guides	Double bar.
Connecting rod, length between centers	10 ft. 4½ ins.
Valve Gear: Type	Stephenson link.
Ports, steam	1⅞ × 19 ins.
" exhaust	2¾ × 19 "
Slide valves, lap	1 in.
" lead	1-32-in.
" max. travel	6 ins.
Boiler: Type	Extended wagon-top.
Diameter of barrel, inside	4 ft. 10⅝ ins.
Thickness of barrel plates	⅝ and 11-16-in.
" of smokebox tube plate	½-in.
Height from rail to center line	8 ft. 8 ins.
Length of smokebox	5 " 6¾ "
Working steam pressure	190 lbs.
Firebox: Type	Regular.
Length, inside	10 ft. 0⅝ ins.
Width, inside	3 " 5 "
Depth at front	6 " 1½ "
" at back	5 " 1 "
Thickness of side plates	⅝-in.
" back plate	⅝-in.
" crown sheet	7-16-in.
" tube sheet	½-in.
Grate area	34.27 sq. ft.
Staybolts, diameter	1 in.; pitch 4 ins.
Water space, width, front, 4 ins.; back and sides, 3 "	
Tubes: Material	Iron.
Number	251
Pitch	3 ins.
Thickness	No. 12 W. G.
Diameter, outside	2¼ ins.
Length between tube plates	14 ft. 6½ "
Total fire area of tube openings	3.469 sq. ft.
Heating Surface:	
Ratio to grate area	64.0 to 1
" of exterior tube area to firebox surface	19.725 to 1
Tubes, exterior	1,978.52 sq. ft.
Firebox	215.20 "
Total with exterior tube area	2,193.72 "
Miscellaneous:	
Exhaust nozzle, diameter	5, 5¼ or 5½ ins.
Smokestack, smallest diameter	18 "
Smokestack, height from rail to top	14 ft. 11 ins.
Capacity of tank	4,000 gallons.
Capacity of coal space	7,244 lbs.
Brake fittings, American, c. a. equalized brake operated by Westinghouse air fixtures.	
Tractive force per lb. effective press. on piston	.147 lbs.
Total tractive force with effect. press. = 4-5 of boiler pressure	22,344 "
Total adhesive tractive power at ¼ of weight on drivers	28,200 "

GOLD ORE BALLAST was recently an unintentional feature of the track of the Union Pacific, Denver & Gulf Ry. Mr. T. F. Dunaway, General Superintendent, writes us that some weeks ago the road was hauling a lot of gravel ballast from the yards of a smelting company, and through the error of the employees of the railway and the smelting company three cars of gold ore were coupled up with several cars of gravel and unloaded as ballast. The error was discovered, and the ore reloaded and delivered to the smelter. The ore was worth about $1,000 per car, and it looked so much like the gravel ballast that only an expert could have told the difference.

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The progress made by the railways in equipping their freight cars with automatic couplers and power brakes, in accordance with the act of Congress approved March 2, 1893, is being investigated by the Interstate Commerce Commission. According to an order issued by the Commission on July 3, last, the day following the date of this issue, is the last one remaining to railway companies for filing with the Commission the information asked for in the following list of questions:

(1) Total number of freight cars owned Sept. 1, 1897.
(2) Number of freight cars equipped with automatic couplers between April 1, 1896, and Sept. 1, 1897, including type and kind of coupler used.
(3) Number of freight cars equipped with power or train brakes, other than hand brakes, between April 1, 1896, and Sept. 1, 1897, including kind of brake used.
(4) Total number of locomotives owned Sept. 1, 1897.
(5) Number of locomotives equipped with power driving-wheel brakes between April 1, 1896, and Sept. 1, 1897.
(6) Number of freight cars, if any, purchased or built between April 1, 1896, and Sept. 1, 1897, which are not equipped with automatic couplers.
(7) Number of freight cars, if any, purchased or built between April 1, 1896, and Sept. 1, 1897, which are not equipped with power or train brakes.
(8) Number of locomotives, if any, purchased or built between April 1, 1896, and Sept. 1, 1897, which are not equipped with power driving-wheel brakes.
(9) Estimated percentage of total freight cars which will be equipped with automatic couplers by Jan. 1, 1898.
(10) Estimated percentage of total freight cars which will be equipped with power or train brakes by Jan. 1, 1898.

This order of the Commission brings forcibly to mind the fact that barely three months remain to railway companies in which to comply with the safety appliance law. According to this act, as will be remembered, it will be unlawful after Jan. 1, 1898, for any railway engaged in interstate commerce to run cars not equipped with couplers locking automatically by impact and unlocking from the side of the car, without the entrance of brakemen between the cars. It will also be unlawful for a train to be run which has not a sufficient number of cars equipped with power brakes to enable it to be controlled wholly by the engine driver from the locomotive. The act also provides that the Interstate Commerce Commission may "upon full hearing and for good cause" extend the period within which any railway shall comply with the provisions of the law.

As everyone knows, there are very few railway companies which will be in a position to comply with the law on Jan. 1. Even the companies which have been foremost in getting their cars equipped with M. C. B. couplers and air-brakes will be handicapped by the foreign cars which they will have to handle that are not so equipped. Moreover, it will not be possible to refuse such cars in interchange without causing a general car famine and an interruption to freight movement that would be a public calamity. As for the railways ignoring the law, that is not likely to happen, for the penalties are severe and suits could be instituted by discharged employees, or other persons having a grudge against the railway companies.

It is practically certain, therefore, that the railway companies generally will have to petition the Interstate Commerce Commission for an extension of the time in which they may put their equipment in shape to comply with the law. The Commission is, of course, aware of the situation, and the circular quoted above is doubtless intended to give it such information as will enable at least a preliminary judgment of the good faith of the railways in their attempts to comply with the law.

We do not apprehend that the Commission will use its authority as a whip to punish those companies who have defied its authority in the matter of rates; but it will be certainly somewhat awkward for the managers of some certain railways which have been prominent in disputing the orders of the Commission to be compelled now to go before this body and beg for its leave to continue the operation of their roads.

It will also be exceedingly awkward for the railway managers, who down to a recent period have taken no steps toward equipping their rolling stock with air brakes and M. C. B. couplers, to explain to the Commission why they ignored the law's requirements for so many years.

We do not see that the Commission can take any other course than to grant an extension of time to the railways; but they are likely to condition this grant upon assurances from the railway companies that will very materially hasten the work of completing the equipment with brakes and couplers.

The latest decision regarding the use of alum in mechanical filtration, printed in full in another column, will doubtless give additional strength to the already strong tendency towards slow sand filtration. This tendency has been due, in part, to the rapid advances in knowledge regarding the great efficiency of slow sand filtration, and in part to the litigation over the use of coagulants in mechanical filtration that has been waged so fiercely for the last three or four years. Although the decision of Sept. 20 is more sweeping than any of the previous ones, there will probably be still more litigation before the various mechanical filter companies now competing with the New York Filter Manufacturing Co., the successful complainant in the present case, yield to that company a practically absolute monopoly of the mechanical filter field.

Moreover, the Hyatt patent on the use of coagulants expires in less than four years, and recent developments tend to show that some of the work done by coagulants can be accomplished more effectively outside than within a filter, that is, in settling basins. It will, therefore, be a natural step, in the case the present decision stands, and is as broad as it seems to be, to adopt combined settling basins and filter beds operating at a moderate rate, with the idea that by the time the consumption of water has so increased as to demand a higher rate the patent in question will have expired and the desired rate may be secured by the addition of the coagulating process. The same general course might be pursued with mechanical filters. In many instances all thoughts of mechanical filtration, with or without a coagulant, will be abandoned, and slow sand filtration be installed once for all, rather than choose between a possible monopoly on the one hand and possible litigation on the other, even if both are sure of termination in a very few years.

Those who have had occasion to follow the course of patent causes are well aware that sharp distinctions are often drawn between the meaning of the same term at different stages in the development of an art or science. It is only by keeping this fact in mind that one can understand how Judge Coxe can advance the ideas regarding settling basins expressed in his decision, published in another column, regarding the use of a coagulant in mechanical filters at Elmira, N. Y. Even with this fact in mind, there seems to be good reason to question whether the judge's conception of settling basins is correct.

The decision seems to hold that in the year 1884 the term "settling basin," as used in connection with the purification of water, meant a receptacle in which water was brought to a state of rest for a number of hours for the purpose of depositing suspended matter on the bottom of the receptacle, and that this definition of the term would, throughout the life of a patent, exclude from all consideration as a settling basin a receptacle through which water passed continuously, a coagulant being used in each instance.

In the case under consideration the defendants claimed that a tank through which water containing alum passed continuously on its way to a filter bed effected a material amount of sedimentation, was a settling basin, and thus avoided an infringement of the Hyatt patent for purifying water in such a way as to make settling basins unnecessary. As to the amount of sedimentation effected in this case we do not concern ourselves, as apparently the court also did not, for it says:

> Even though they (the defendants) should increase still further the capacity of the cisterns through which they pass the flowing stream, it would not avail them.

And in another part of the decision the court holds that if the particular cisterns, as it terms them, are settling tanks, then others effecting less sedimentation are as truly so. To put the matter in another way, settling basins, to be such, must be operated on the intermittent plan, all basins operated continuously, without regard to their size, or the amount of actual sedimentation accomplished, being—not settling basins. Now, as a matter of fact, settling basins, without the use of coagulants, were operated on the continuous plan in connection with sand filter beds long before the date of the Hyatt patent, and though some, at least, were small, they were found to be valuable aids to water purification, and it was known that if they were larger they would be still more effective. In the purification of sewage the consensus of opinion among American engineers who have designed works for this purpose, is that continuous settling tanks are to be preferred to intermittent tanks. In the present state of the art, it is certain, intermittency of action is not the test of whether or not a given receptacle is a settling basin, the real question being, is sedimentation accomplished? The most important point to be decided is, which plan is the most efficient. The time element is an important factor. Chemicals have long been used in both water and sewage purification to lessen the time required for sedimentation, and it seems very doubtful whether in view of both past and present practice, the term "settling basin" can be correctly limited to a receptacle operating on the intermittent plan.

Word has been received from the Hudson Bay exploring expedition which was dispatched by the Canadian Government last spring to investigate the possibilities of making Hudson Bay the terminal of a line of transatlantic steamers to be run in connection with a railway from Winnipeg, Manitoba, to Hudson Bay. A press dispatch from St. Johns, Newfoundland, to which the expedition returned on Sept. 25, says:

> The expedition made six passages through Hudson Strait, visited Cumberland Sound, explored the coast of Baffin Land and discovered a large lake in the interior, trawled for codfish without success, surveyed both shores of Hudson Strait, visited Fort Churchill, and obtained a lot of information from the factors there, steamed 30 miles up Ungava River, and reached Fort Chimo. The expedition reports unfavorably upon the commercial value of Hudson Bay as a steamship route, owing to fogs, shoals, icebergs, want of lighthouses, and the country being bleak and barren, with no communication with civilized regions. The expedition will return again in a week to make a final run through the strait to determine exactly when navigation closes. All the explorers are well.

As we stated in our issue of May 27, 1897, this is the second exploration which has been organized and paid for by the Canadian Government in the interest of this foolish scheme. The first expedition, made in 1884, proved conclusively to every sensible man the commercial impracticability of a short-cut railway and steamship route to Europe by the way of Hudson Bay; but so great has been

the political influence of the Hudson Bay Ry. promoters that in spite of the condemnation of the whole scheme by the officer in charge of the exploration additional subsidies have been voted by the Canadian Government almost every year since, and finally the present expedition was ordered at the public expense. The promotors of the enterprise have been utterly unable to interest private capital in their scheme, since the early nineties, which they succeeded at the expense of some too credulous contractors in building 40 miles of line northeast from Winnipeg. It will be seen that the present exploration has done nothing but confirm the observations of the first expedition; but it will be well worth its cost to the Canadian people if it induces the Government to refrain from spending further money on the enterprise.

In the newspaper reports of the recent disastrous head collision in Colorado, in which 30 persons were killed, it was stated that the horrors of the accident were increased by the explosion of one or more of the Pintsch gas cylinders upon the wrecked cars. The statement seemed to us so improbable that we gave it no currency in our columns, preferring to wait until further investigations should determine the actual facts of the case. Our caution now proves to be well grounded. The five cars which were wrecked were equipped with nine Pintsch gas cylinders, or tanks, as they are commonly called. All of these nine cylinders have been recovered from the wreck and shipped to Denver, and we have been favored with the following official report on their condition:

To the Denver & Rio Grande Railroad Co., Denver, Colo.,

Gentlemen: We were this day duly requested to examine the tanks that were loaded on D. & R. G. coal car No. 15,214, being shipped in this car from the place of accident to Denver, and are, as we understand, the Pintsch gas tanks removed from the recent wreck at New Castle.

We saw these tanks unloaded and brought to a platform near your storehouse at Burnham, and the nine tanks were marked from 1 to 9, also the date 9-20, and the number of the car, 15,214, being marked on with paint on the ends of these tanks.

Tank No. 1. Heads good; body badly dented; all rivets intact.

No. 2. This tank is not dented and rivets all in place.

No. 3. Both heads good; body slightly dented; rivets in place.

No. 4. Both heads good; body dented very little and rivets good.

No. 5. One head slightly dented and one good; the body dented badly; rivets all in place.

No. 6. Nearly perfect; some slight dents in body and three screw bolt heads knocked off; apparently knocked off after fire.

No. 7. Nearly perfect, with the exception of one bolt head on one of the heads broken off; apparently done before the fire.

No. 8. Very badly dented and bent; one of the heads dented and small hole ½-in. long × 1-32-in. wide knocked in it; rivets and bolts all in place; one head good.

No. 9. Badly bent and out of shape in middle; heads good; all rivets in place and seem to be good; no indication either on body or heads of a rupture.

All these tanks had the appearance of going through the fire, and were more or less bent, dented and burnt; and on account of the excessive heat, the solder in the joints was melted out and they were more or less warped; but on none of these tanks, no matter how hot they seem to have been, or whatever strain they were subjected to, on account of parts falling on them, is there the slightest indication of an explosion, and we can state without hesitation that these tanks were not exploded at the wreck or anywhere else, and, from all appearances, they were in first-class condition before the accident.

They are the tanks furnished by the Pintsch Gas Company, and the mechanism of these tanks is first class.

Signed, Henry Schlacks, Superintendent Machinery.
W. H. Hooper, Representative Pintsch Gas Co.
C. H. Quereau, General Foreman B. & M. R. R.

Denver, Colo., Sept. 20, 1897.

This report settles the question as to the reported explosion of the Pintsch gas reservoirs upon the wrecked cars. It now remains to be considered what did cause the explosion, for it is clearly shown by the testimony of trainmen and passengers, that an explosion with a sharp report occurred between one and two minutes after the collision. The center of the explosion appeared to be underneath the smoking-car (the second car back from the engine). Two theories are offered to explain the explosion. One is that a passenger in the smoking-car may have had some dynamite with him—a not unlikely occurrence in this mining district; but if this were the cause of the explosion, one would expect the explosion to be simultaneous with the collision. Another theory is that the shock of the collision started the gas tanks underneath the smoker to leaking, and that the escaping gas mixed with the air is some more or less confined space underneath the wreck in the right proportions for an explosion. The ignition of the gas is accounted for on the theory that some one may have lit a match, or coals from the locomotive ash pan may have been scattered along the track.

To what extent the explosion was responsible for deaths or injuries will never be certainly known; but one man who was in the smoker when it occurred received no injuries save slight burns. Whether the explosion caused the fire or not is also uncertain; but there is testimony that the wrecked freight cars were set on fire by coals from the locomotive. This is a fair summing up of what is known or probably ever will be known as to the part played by the gas lighting equipment in this terrible accident. There appears to be nothing in it to change the opinion which conservative railway officers have generally formed as to the practical safety of this system of car lighting.

We cannot refrain from remarking that it is a pity the public cannot be given equally full information as to the defective system of train despatching or train operation which was the cause of the accident, and to which this great loss of life is directly chargeable.

THE EFFECT OF A PURE WATER SUPPLY ON TYPHOID FEVER IN NEWARK AND JERSEY CITY.

Two remarkable instances of a decrease in typhoid fever following a change from a sewage-polluted to a pure water supply have recently occurred in Newark and Jersey City. Both of these cities were for many years dependent upon the Passaic River for their water supply. The pumping stations of the two cities were about a mile apart, and but a few miles below the cities of Paterson and Passaic, the sewage of which is discharged into the river. Other communities contributed more or less to the pollution of the stream.

On April 26, 1892, the city of Newark abandoned the Passaic River and began using water brought some 25 miles from the Pequannock River, by means of works built by the East Jersey Water Co. This stream is one of the highland tributaries of the Passaic, having a sparse population in its drainage area. Immediately after making this change in its source of water supply there was a great drop in the number of deaths from typhoid fever in Newark, but Jersey City, which used the Passaic water for about four years longer, continued to have a high mortality from typhoid fever until it also changed to the Pequannock supply.

The accompanying table has been prepared to show in detail the effect of pure water on typhoid in these two cities. The table has been made to cover a period of 11 years, or from June 30, 1886, to June 30, 1897, in order that it might contrast five years of impure water and five years of pure water in Newark, leaving the year 1891-2 to stand by itself.

From this table it appears that in Newark for the five years when the supply was from the polluted Passaic the average number of deaths from typhoid fever was 70 per 100,000 of population, and that for the five years after the change to Pequannock the typhoid mortality was only 25 per 100,000.

Jersey City continued to use the foul Passaic for over three years after Newark changed to the Pequannock, so that its record for three years before and after Newark changed can be compared with the Newark record for the same period. Doing this, we find that for the three years ending June 30, 1891, Newark lost 85 per 100,000 of its citizens from typhoid, and Jersey City 95. For the three years ending June 30, 1895, Newark lost but 25, while Jersey City lost 71 per 100,000. Doubtless the water supplied to Jersey City during the last three-year period was actually worse than that furnished previously, although the typhoid death rate per 100,000 was less. This may be accounted for by the fact that the people were better aware of their danger in the later than in the earlier period, and, therefore, took more pains to avoid the use of the crude Passaic for drinking purposes, some boiling and others filtering it before using, while many bought mineral or spring water. Besides this, it has been suggested that in a community using polluted water year after year, many people became partially or wholly immune. Credit should also be given to increased skill on the part of doctors and nurses and increased vigilance on the part of health authorities in controlling infectious diseases.

The Pequannock supply was introduced gradually in Jersey City, an increasing percentage of the total consumption being furnished month by month during 1896, until in October the Passaic was entirely abandoned. The typhoid fever diminished with the decrease in the use of the Passaic water, as is shown by the following figures:

Month.	Per cent. Passaic water used.	Deaths from typhoid fever.	Month.	Per cent. Passaic water used.	Deaths from typhoid fever.
January	72	28	July	20	3
February ...	60	30	August	24	3
March	57	16	September ..	30	3
April	42	9	October	11	4
May	50	6	November ...	0	1
June	20	7	December ...	0	5

These figures are all the more striking since typhoid fever is generally more prevalent in the latter part of the year than at any other time.

For the year ending June 30, 1897, Jersey City used no water from the Passaic River. Her typhoid death rate for that year fell to 19 per 100,000 population, against 20 in Newark. For the year ending June 30, 1895, the last full year shown in the record during which Passaic water was used, the typhoid death rate in Jersey City was 93 per 100,000. The relative number of total deaths from typhoid in each of the two years was 174 in 1894-5, and 38 in 1896-7, or a decrease of 136. Part of this decrease is doubtless due to other causes than improved water supply, both Newark and Jersey City showing a marked decrease in the last few years in their total mortality rate. Newark has been gradually improving in this particular ever since the Pequannock supply was introduced. As it has now been five years since that event and the typhoid mortality has kept at a pretty constant rate, with one exception, ever since, it is only fair to give other departments of the city some credit for the reduction of the typhoid mortality. This seems all the more reasonable, since in 1895-6 the typhoid jumped from 21, for the two previous years, to 29; while the total mortality rate fell one point. Moreover, Jersey City showed a decrease in its total death rate before the new water supply was introduced.

Too much stress should not be laid upon the minor variations in these figures, for it is a well-known fact that mortality returns in this country are at best quite imperfect, and all populations between census years have to be estimated. In the present case the geometrical rate of increase in population between national census years was used in computing the yearly populations. This method gives a result for the year 1895 about 9,000 below the State Census for Newark, and about 4,000 above that for Jersey City, or about 4% less, and 3% greater, respectively. These differences have very slight effect upon the death rates for 1895, but, of course, the discrepancy increases as the years go by. The tendency of these discrepancies is to make a worse showing for Newark, and a better one for Jersey City than would otherwise be the case, but this is so slight as not to affect in the least the main lesson of the table, that pure water materially reduces the typhoid death rate of a city.

Column after column of figures might be presented in support of this conclusion, but it is now so generally accepted by engineers and sanitarians that it seems quite unnecessary to do so. Instead of this, attention may be called to the fact that there are many cities in this country with typhoid death rates in excess of those prevailing in Newark and Jersey City, since the introduction of the Pequannock water, and that an improvement in the water supply of such cities would doubtless reduce their typhoid death rates, also. The citizens of Newark and Jersey City will also do well to

note that, notwithstanding the improvement in the character of their water supplies, there are other cities in this country, and many abroad, with a still lower typhoid mortality, and that the indications are that this is due to the fact that water yet purer than that now furnished in these two cities is served to the other municipalities mentioned.

Surface waters from large drainage areas are bound to receive some pollution unless the most vigorous and advanced measures are taken to prevent it. The Pequannock drainage area is sparsely populated, but as yet very little has been done to exclude from the streams the human wastes from the comparatively few houses near them. Typhoid fever is considered a pretty accurate index of the quality of the water supply of a community, as we have seen above. It is, therefore, pertinent to inquire whether the fact that in some foreign countries all surface water supplies must be filtered, and the further fact that where filtered water is furnished, a typhoid death rate below that of Newark and Jersey City prevails, whether these facts do not indicate that still more lives might be saved in these two cities if the water supply was either more closely guarded from pollution or the water subjected to filtration? This question is not submitted in a hypercritical spirit, but merely to cause reflection and to suggest to both communities the possibility that their sanitary condition might be still further improved. If the respective water supplies are as safe as nature and man can make them, then it might be well to look elsewhere for chances for improvement.

These two cities are to be most heartily congratulated for having escaped from further use of the vile Passaic. Scores of human lives are yearly being saved in each city on that account. Who can fully appreciate what that means? For every life saved many cases of typhoid not fatal are prevented, thus adding to the thousands of dollars which otherwise would be required for nursing and medical attendance of typhoid patients and in burying the dead. Improvement in the health of a community adds to its attractiveness as a place of business and residence, and affects it in a great variety of ways. Thus indirectly, as well as directly, pure water pays.

But as yet Jersey City has arranged for only a temporary supply. At best it cannot enjoy the Pequannock after 1900, for it will then all become the property of Newark, and Newark is bound by its contract with the East Jersey Water Co. not to sell any Pequannock water outside of its own limits, except to one or two small towns adjoining it. Since the temporary contract for Pequannock water was made between the East Jersey Water Co. and Jersey City, a second temporary contract has been made by the same parties in which the company agrees to prepare itself to supply Jersey City with water from the Passaic River at Little Falls, above Paterson and the other main sources of pollution of the river. While this second temporary contract is in force (it being terminable at will by Jersey City), it is supposed that arrangements will be made and carried out for a permanent supply. It is to be hoped that this will prove to be as good as or even better in quality than the Pequannock supply. The Passaic, at Little Falls, cannot be so considered, since the river flow at this point includes all the run-off from the central section of the Passaic River, including the Great Meadows and other low lands, much of which are flooded at high water. This tends to give the water both high color and a large amount of organic matter of vegetable origin, besides which the water at times of flood is more or less turbid. There are, also, several fair-sized and growing towns in the drainage area above Little Falls, but the present population of the whole drainage area is small, compared with that on many water supplies of fair character. As all these towns are without sewerage systems, with one exception, and that one has a well-designed intermittent filtration plant for the purification of its sewage, the danger from sewage pollution ought easily to be kept as nearly at a minimum as is possible where villages and towns exist at all in water supply drainage areas.

Whatever else may be necessary, Jersey City may well be thankful that it need never revert to the Passaic below Paterson for its water supply. After having enjoyed the Pequannock for a few years, it remains to be seen how the Passaic at a point even so far up as Little Falls will be relished. Certainly, if experience is really anything like as good a teacher as is commonly reported, Jersey City must by this time have learned the curse of bad water, and the blessings of a pure supply. Newark has made good provision for its future water supply. It remains for Jersey City to do the same. Upon the final outcome at Jersey City may depend to a large extent the future water supply of a number of municipalities between the Orange Mountains and the Hudson River, for the water situation in northeastern New Jersey is complicated, and the outcome of Jersey City's efforts is likely to affect many other neighboring municipalities.

Since the above was put in type, specifications for a permanent water supply for Jersey City have been submitted to the authorities, as outlined elsewhere in this issue. These specifications, as far as can be judged from the outline made public, show that their authors appreciate the value of pure water and intend to secure the permanent enjoyment of it for Jersey City.

Mortality from Typhoid Fever in Newark and Jersey City Before and After Introducing a Pure Water Supply.

	Newark					Jersey City				
	Deaths			Death rate.			Death rate.		Deaths	
Year ending June 30.	Total.	Typhoid.	Population.	Total per 1,000.	Typhoid per 100,000.	Typhoid per 100,000.	Total per 1,000.	Population.	Typhoid.	Total.
1887	3,734	84	164,300	23	51	55	25	146,900	81	3,686
1888	4,183	76	169,200	24	45	75	26	151,300	114	3,980
1889	4,253	131	174,200	24	75	85	26	155,700	132	4,065
1890	4,948	194	179,300	28	108	99	27	160,400	159	4,258
1891	4,420	134	184,500	24	72	101	26	165,400	167	4,386
1892	5,641	153	190,000	30	81	72	27	170,500	123	4,633
1893	4,900	63	195,600	25	32	66	26	175,700	116	4,531
1894	4,760	43	201,200	24	21	53	24	181,100	96	4,320
1895	4,643	43	206,900	22	21	93	24	186,600	174	4,497
1896	4,628	61	212,600	22	29	82	23	192,300	158	4,407
1897	4,496	44	219,100	20	20	19	19	198,200	38	3,735

LESSONS OF THE ELEVATOR ACCIDENT IN THE TRACT BUILDING.

The verdict of the coroner's jury in the case of the elevator accident in the building of the American Tract Society, on Sept. 10, which was discussed at length last week, was rendered on Sept. 24, after a three days' investigation, as follows:

We find that the accident was occasioned by the release of the safety guards of the elevator after the same had been pawled.

We find that no one who understood the system in use was in charge at the time, but hold no one criminally responsible for the accident; and we recommend, as citizens of the community, that high-speed elevators, the use of which is open to the public, should be in charge of a competent engineer at any and all times.

The jury which found this verdict was composed of men of a high grade of intelligence; some of them being architects and civil engineers. The verdict is probably as good a one as could be expected, in view of the evidence presented, much of which was contradictory as to statements of actual or supposed facts, and vague as to probable causes of the accident. In holding no one criminally responsible for the accident (the engineer who might otherwise have been so held being killed), and in recommending that high-speed passenger elevators, when in use, should at all times be in charge of a competent engineer, the verdict is undoubtedly just and right. In regard to the statement of the cause of the accident, however, we think the verdict might be improved upon. The engineer's act of releasing the safety grips after they had been "pawled" no doubt led to the accident taking place, but his action was not the sole cause. If when he released the grips the lifting apparatus had all been in proper order, the accident would not have happened. In order to produce the accident it required, in our opinion, in addition to the wrongful act of the engineer in releasing the grips before he had proved that the machinery was all in order, the combination of two entirely separate and distinct defects in the condition of the apparatus, both of which defects the engineer should have discovered and had remedied before he released the grips, together, possibly, with a second wrongful act by him.

The first defect in the condition of the apparatus, to which we refer, was the breaking of the connection of the governor rope with the small rope which operates the drum of the safety device. This connection was broken by the act of operating the safety device, which caused the locking of the elevator car 20 minutes previous to the accident. The connection having been broken, and the safety device having been thereby made inoperative, the car should not have been run again until the connection had been repaired.

The second defect was that the plunger in the tall cylinder was no longer supported by a pressure of water beneath it, but rested on air or vacuum.

These two defects combined, however, would not have produced the accident, had the engineer, just prior to releasing the safety grips, moved the valve so as to admit the full pressure of 250 lbs. per sq. in. from the accumulator to the cylinder (provided a vacuum existed above the water in the cylinder, for by so doing he would have filled the cylinder up to the bottom of the plunger, with water, and the sudden drop of the plunger would have been thereby prevented.

Had there been air, instead of vacuum, above the water in the cylinder, it is possible that the accident could not have been prevented by the engineer's moving the valve so as to admit the high pressure to the cylinder.

In connection with his testimony before the coroner, Dr. Chas. E. Emery performed a very interesting experiment with a small syringe and a glass of water to show what would be the effect of air enclosed above the water in the cylinder. The syringe was about 4 ins. long and ¾-in. diameter, and had a very contracted outlet, so as to discharge a very small stream. After charging the syringe half with water and half with air, the outlet pointing downwards, and the air being in the upper part, the piston being above the air, force was applied to push the piston downwards and expel the water from the nozzle. By so doing the air was strongly compressed above the water, and the water escaped from the nozzle at high pressure, while the piston slowly descended. When the water was all forced out of the syringe, the piston appeared to jump suddenly downwards and expel the air almost instantly.

Applying the lesson of this experiment to the case of the elevator plunger, assuming air to be above the water, the admission of the water pressure of 250 lbs. per sq. in. at the valve at the bottom of the cylinder would compress the air to this same pressure, which would sustain the weight of the plunger, partly counterbalanced by the weight of the car, just the same as water would sustain it. Then when the valve was opened so as to discharge the water from the cylinder, the water would escape at the ordinary speed, being restricted by the size of the openings in the valve and discharge pipe; but when the water was all out and the air reached the discharge valve, the air would escape many times as fast as the water (the relative rate of flow being in the ratio of the square roots of the densities of air and water), and the plunger would suddenly receive a high acceleration to its speed, which, continuing, might cause the elevator car to shoot upwards to the top of the shaft.

The other wrong act of the engineer, that is, the one besides his releasing the safety clutches before he knew that the apparatus was in order, was his opening the discharge valve of the cylinder before he knew that the cylinder was full of water to the top, so that neither air nor vacuum should be below the bottom of the plunger.

It appears, therefore, that instead of the accident being due to a single cause, it was due to the combined action of four causes, the absence of either one of which would have prevented it; two of them being defects in the condition of the machinery, and two of them wrongful acts of the engineer.

The probability that four such causes may again be combined within any reasonable number of years is extremely slight. The probability of any fatal accident happening to a passenger in a high-speed elevator may be said to be far less than that he will be killed by falling down stairs in his own home, or that he will be killed by lightning. Nevertheless, it behooves the builders of elevators not to rest satisfied with any system of elevator construction in which it is possible for two distinct struc-

tural or operative defects to exist at the same time, which, conjointly with the negligence or ignorance of the operator, may cause a fatal accident. It was said before the coroner's jury, and no doubt truly, that nothing that human foresight could suggest to insure safety was omitted in the construction of this elevator. It may be, however, that human hindsight, which is usually better than foresight, may remove the causes of the two defects in the condition of the apparatus which contributed to its failure.

The safety clutch apparatus is a wonderfully effective and well-constructed machine. It does seem, however, that the method used to operate it, viz.: pulling on its drum by a small rope attached to the governor rope, is defective in that a single successful operation of the safety grips is apt to cause the breakage of this small rope, so that the apparatus cannot again act until the broken rope is replaced. It may require a high degree of inventive skill to provide a remedy for this defect, but it seems to us that elevator builders should not be satisfied until it is remedied. The defect of air or a vacuum being under the plunger seems clearly due to leaks of air or water, or both, in the pressure tank in the cellar of the building. The pressure in this tank was kept up by an air pump, which was started by hand whenever the pressure gage indicated that the pressure had gone down, provided that the attendant observed the pressure gage. It would appear easy to make the operation of the pump automatic, and in addition to have an alarm bell rung by a decrease in the pressure if from any cause the automatic pump got out of order. A better remedy, however, would be the abolition of the air pressure tank entirely, and the substitution for it of an open tank located at or near the level of the top of the cylinder. By this means the cylinder would always be kept full of water by the action of gravity instead of by air pressure.

LETTERS TO THE EDITOR.

The Personnel of the Civil Engineer Corps, U. S. N.

Sir: In your issue of Sept. 9th you practically stated that the system which places the Civil Engineer Corps, U. S. N., under a non-professional chief of bureau is largely responsible for the lamentable position in which the Bureau of Docks and Yards has found itself this past summer. Such being the case, I have been a bit hasty in rushing into print, and I sincerely regret if I have in any manner reflected upon the individuals of the corps of civil engineers.

Regarding the appointments made in that corps in July last, as the result of a competitive examination, I find I was misinformed. Both of the gentlemen appointed were holding professional appointments in the United States service at the time of their appointment as civil engineers in the navy, and for any annoyance caused them or their friends by my misrepresentations, I tender my sincere apologies. Respectfully submitted, John Martin.

New York, Sept. 27, 1897.

Truss Design and the Sixth Street Bridge at Pittsburg.

Sir: As I have just returned from abroad, I am necessarily late in replying to the two communications contained in your issue of Aug. 12th. These communications had reference to the bridge design described by me in your issue of July 22d.

I would remind Mr. Moiseiff that the well-known bridge types which he mentions are true suspension bridges. There is no compression member, and the pull of the tension members (or catenary) is resisted by the anchorage, in whatever form this may be introduced. The span is, therefore, not self-contained, but is dependent for its equilibrium upon something outside of itself, i. e., on the adjoining spans. This arrangement has the disadvantage that changes from temperature are difficult to manage. In the case of the Point bridge at Pittsburg, or the Fidler truss, these temperature changes produce a rotary motion around the center pin of the eyebars which are connected to it. If a lubricated joint is introduced, bulky connections and expensive and inconvenient details are necessary, and the bridge will require constant attention to insure that the lubricant is applied. If the joint is treated as an ordinary pin connection, with the pressure upon the bearings running up to from 12,000 to 18,000 lbs. per sq. in., as has been done in some cases, the element of wear is introduced, and a restricted life given to this detail.

The type of truss described by me is a truss in every sense. The introduction of a compression member, in the form of an arched top chord, makes the span self-contained, and temperature changes can be treated in the simple manner customary for truss bridges; viz., by resting one end upon rollers. The upper chord was arched for the same reason for which, in the case of long spans, the top chord in a Pratt truss is arched; viz., to obtain greater depth, and thereby greater leverage, which in both cases results in economy of materials. Making the upper curves of the tension chords concave does produce additional strains in the web bracing, but these are very small in amount. The curves were chosen partly for aesthetic considerations and partly to obtain additional leverage by increasing the distance between the curves, thereby reducing the deflection from partial loading. The concave form is not troublesome for eyebars, and the objection made, that it would be inconvenient for wire cables, is out of place, as these were not in contemplation. I cannot go into the calculation of strains and deflections in detail, as would be necessary to answer one or two of Mr. Moiseiff's questions. The deflections are the usual very moderate quantities resulting from the elastic changes of length of the individual members and correspond closely to the deflections which would occur in a Pratt truss of similar proportions. The strains are statically determinate, and these and the deflections can readily be calculated by known methods. The strain sheet gives the maxima of strains, and these to some extent tell their own story, so far as the very small scale of the illustration permits the reading of the figures.

I would say to Mr. Lindenthal that my statement in reference to the competitions for Sixth Street bridge, Pittsburg, reading "the company invited designs from engineers on two separate occasions, each time offering a prize for the best design," is strictly correct. My own connection with these competitions was in response to direct invitation, unsolicited on my part. The prize offered was $1,000 in money, and the successful engineer was to have charge of the work. Advertisements stating these conditions were published. The explanation given by the company for asking for designs a second time was, that it had been found necessary to change the span lengths, and that the results of the first competition were unsatisfactory. I was never informed what had been the conclusion reached in Mr. Flad's report, but was given to understand that it was not decisive, and that the company did not wish to be governed by it. Until I read Mr. Lindenthal's present statement I was ignorant that his connection with this work was of the special nature described by him. He seems equally without information as regards the dealings of the company with other engineers.

It may here be mentioned that the title to the article in question was not my own and that my purpose was not to make claims of special merit for the form of truss described, but simply to put on record the results of a calculation of strains and sections for a peculiar and unusual form of truss. The strain sheet chosen for this purpose was the one prepared with great care for the competition for the contract. That competition, as stated, came after the competition for the prizes. Charles L. Strobel.

New York, Sept. 15, 1897.

A Question of Professional Etiquette.

Sir: At a time when so much public interest is centered in this city, on account of the widely circulated rumors of a prevalent epidemic of yellow fever, and the divergent opinions of medical men as to the exact nature of the disease, it may not be amiss to recall the recent action of a local medical society, and its dealings with a matter vastly, if not entirely, foreign to it.

As everyone who reads your journal is aware, New Orleans, some time ago, undertook to construct a sewerage system. After a year and a half of labor spent in preparing the data necessary for so important a work, and after calling into consultation the very best engineering talent available, a plan was adopted, and work was commenced.

Concerning the failure of the company to complete the work (after constructing the greater portion of the main sewer—the only really difficult feature of the entire system) the writer has nothing to say, beyond the fact that cessation of the work was by no means due to any insurmountable difficulties encountered, and the enterprise could as readily be executed to-day were funds available and the matter not in litigation; resulting from the city bringing suit for the annulment of the franchise.

After several meetings of the Council Committee on Sewerage, to receive and consider various propositions, etc., from those interested, directly or otherwise, the Orleans Parish Medical Society forthwith grasped the problem, and extended invitations to engineers and others, for the purpose of listening to discussions before it, on questions prepared by the aforesaid society.

The writer cannot now state these questions verbatim, but the leading ones were in substance as follows:

Is sewerage beneficial?

If so, should it be owned and controlled by the municipality, or by a private corporation?

Is it practicable to construct a sewerage system in New Orleans?

Is the Mississippi River the proper point of disposal—if not, where should the sewage be discharged?

It certainly may be within the province of any learned medical or other society to listen to and discuss so broad a question in all its complications, satisfactorily to itself at any rate. When, however, it exceeds the limit for which its general or specific teachings fit it, and at a single meeting denounces what it has taken engineers of the highest standing a great amount of time and study to determine, and when by a majority vote of its members it declares to the city council that the point of disposal, the prime feature of the system, is incorrectly established, and that instead of forcing the sewage into the Mississippi River, at a considerable distance from the banks, and several feet below the low water level, as the adopted plans call for, it should be discharged into a fluctuating "bayou," but a mile and a half from the populated portion of the lower city limits, to rot and fester under a semi-tropical sun, by what code of professional ethics can it justify its action?

No self-respecting engineer or body of engineers would have rendered a decision, arrived at so hurriedly, even were they convinced that wrong methods were being employed. A consultation at least would have taken place, and "pros" and "cons" would have been considered. But a medical society acts differently; it knows all about canals, alimentary and other sorts, and the arteries associated with them. The patient is ill, and must be relieved. If an emetic won't, in their opinion, afford the necessary relief—well, a compound cathartic may, and instead of discharging in front, as the engineers say New Orleans should, the medical men insist she shall be relieved in the rear.

Is sewerage beneficial?

Has any intelligent man, with the most elementary knowledge of sanitation ever doubted it, provided, of course, that the system is well designed and operated?

Wherever established, do not statistics show its beneficial results, in a reduced mortality?

That it is not impracticable to construct a system of sewerage in New Orleans the work already done gives good proof.

As to whether it should be owned by the city or by private parties, the writer has no opinion whatever to offer, being an engineer and not a promoter.

What view do you, Mr Editor, as the head of an engineering journal take of such a proceeding? Apart from the questions at issue, what sort of professional etiquette does this medical society practice?

Would it not be just as proper for a handful of engineers to meet, learning that an important surgical operation was to be performed, and inviting the medical profession before them, to say: "There, gentlemen, is a most important case that you are about to probe, we as engineers are by no means satisfied that you fully know what you are about, therefore we desired to see this matter discussed, and we have prepared the following questions for you:

"Is surgery a success?

"If so, should it be performed by private practitioners or under the supervision of hospital students?

"Is the method we learn you are about to employ safe?

"Do you not think that in lieu of severing certain sinews in the leg, to straighten the patient's club-foot, that the same benefit would be derived if you lopped off his right ear?"

The peculiar inconsistency of the entire proceeding, however, becomes apparent by comparison.

This city only recently undertook the execution of a system of drainage at an estimated cost of $8,000,000, preparatory plans for which were made under an advisory board of engineers, two of whom (Mr. Rudolph Hering and Major B. M. Harrod, the former the well-known hydraulician, and the latter President of the American Society of Civil Engineers), were also consulting engineers for the sewerage system and indorsed the plans which the medical society rejects.

The $8,000,000 enterprise is under way, without question as to its efficacy, while the $2,000,000 sewerage project is discountenanced by a board of medical experts.

Such interferences from those who should help instead of obstruct progress are what tend to keep this otherwise progressive city continually in the rear.

Yours truly,

Aubrey R. Littlejohn, Civil Engineer.

710 Union St., New Orleans, La., Sept. 21, 1897.

A Lake Trip on an Ore Carrier.

Sir: The low price of structural material which has prevailed of late years can more easily be understood when one gains some comprehension of the growth of the traffic on the Great Lakes. Taking a record at random, that at Detroit on Sept. 4, it shows that 63 vessels passed up and 60 vessels passed down the Detroit River in 24 hours—a total of 123 vessels. In fact the traffic takes on much the character of a procession.

Leaving Cleveland, from the ore docks, on one of the big steel ore boats, three hours is consumed by the tugs in towing the vessel down the Cuyahoga River past the numerous vessels, around the sharp turns and through a succession of drawbridges. The thick black water in the river gives much meaning to the joke of the minstrel "end man," who said he fell on the river, and when they picked him up, he had the water-scraped off his clothes. Cleveland, apparently, has no larger problem to solve than the disposal of its sewage.

Near the mouth of the river the first section has been widened nearly up to the Superior St. drawbridge, and work is being done preparatory to completing another section to a point above the Cleveland Terminal & Valley Ry. draw. This company has prepared plans for the length-

ening of the present drawspan and the rebuilding of the end pier, and contracts are soon to be let for the work. The plans were made by A. L. Hyde, Consulting Bridge Engineer, who has recently prepared plans and let the contracts for the new terminal passenger station on Michigan St., for the same company, which is controlled by the B. & O. R. R. The new freight terminals are being built under the direction of Paul Didier, Chief Engineer.

After passing outside the breakwater, the course of the boats is direct for the channel between Pt. Pelee and Pelee Island, and our boat, which was going up without a load, kept up a speed of 12.6 miles per hour. The length of the vessel was 285 ft., and of the usual lake type of flat-bottomed freighters. The engines were triple expansion of 700 HP., the coal consumption for steaming was only seven tons per 1,100 miles, and a crew of only 18 men was required to operate the vessel. This represents a cost per ton for carrying the cargo of 2,500 tons of ore, including interest, insurance and other minor expenses, of less than 40 cts. This has been rendered possible by the improvements effected by the government, through the agency of the U. S. engineers, in deepening the old channels and cutting new ones. Our boat, when originally built, was to carry only 1,600 tons, but was docked last year and strengthened so as to carry 2,500 tons of ore, with a draft of 16 ft. 10 ins.

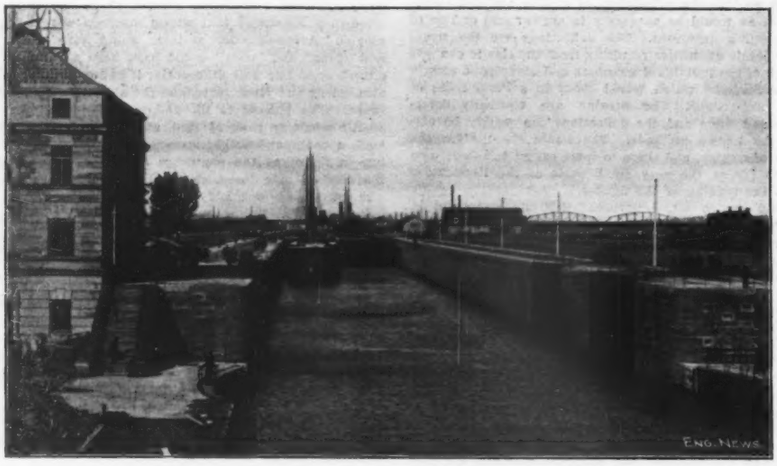
During the winter of 1895-1896 the carrying capacity for new boats was determined by figuring a draft of only 14½ ft., while during the coming winter a mean draft of 16 ft. 6 ins. will be used in the calculations. The available depth of water between Lake Superior and Lake Erie is now 17 ft. 4 ins., the gages reading between 18 and 20 ft. The steamer "Empire City," 426 ft. in length by 48 ft. beam, was one of three vessels constructed during the season of 1896-1897, which were over 400 ft. in length. She has recently broken the ore record by carrying 6,288 net tons of ore from Two Harbors to Cleveland, with a draft of 17 ft. 2 ins. The cost of this vessel was $240,000. Twelve vessels over 400 ft. long were constructed during 1895-1896, the largest being the "Sir William Fairbairn," 438 ft. in length by 45 ft. 6 ins. breadth. The coming season is to eclipse even this record, as the Cleveland Ship Building Co. is constructing a vessel 450 ft. in length by 50 ft. beam, which will cost, it is stated, only about $260,000, owing to cheaper material. The carrying capacity will be about one-third more than the "Empire City." This immense increase in capacity can only result in a very greatly reduced cost of transportation.

In addition, many of the new vessels have one or two steel barges in tow, which are fitted with sails and do not add a great load to the leader, but the load hauled by a single steamer is increased to upwards of 10,000 tons of ore! Whalebacks were passed, which were hauling two whalebacks or "pig" barges. Some of the wooden vessels were seen with four boats in tow, or, in the parlance of the lakes, a "Bay City Funeral."

The air is full of "Rockefeller" rumors, and like his vessels, they are all big ones. It is now said that the big Norrie mine, on the Gogebic range, near Ashland, Wis., is to pass into the hands of the Carnegie-Rockefeller combine. This mine had placed 6,275,841 tons of ore on the market, up to last winter, and its output is three times greater than that of any other mine on the range. The Rockefeller fleet of vessels is to be repaired by the Cleveland Ship Building Co. this winter, and put in shape for the next season.

The government work on the Detroit River is of much interest to an engineer, as the work is of a varied nature. A new rock drill has just been completed by L. P. & J. A. Smith, of Cleveland, for work of this character. The drills at work on Ballard's Reef were very similar to the head of the ordinary rock drill, but were fitted with guides which run in leads similar to those of a pile-driver. Two of these were built on the sides of a flat scow. After the holes are drilled and the blasts fired, a scow fitted with derricks is anchored over the spot and with the assistance of two divers the loose rock is removed. A dipper dredge was also at work near by, removing softer material to deepen the channel.

The work of beautifying Belle Isle Park is being done in a manner highly creditable to the city of Detroit. The stone arch bridges and other structures in the park



THE UNITED STATES LOCK AT SAULT STE. MARIE, MICH.

are especially noteworthy. Just off Thunder Bay, in Lake Huron, an interesting piece of work is in progress. About 30 years ago, the "Pewabic," loaded with copper, and having a large number of passengers on board, sank in Lake Huron, as the result of a collision. Last year the location of the wreck was discovered, but as the depth of the water was about 160 ft., it could not be reached by divers, and resort was had to a diving bell. The wrecker "Root" is anchored over the wreck, and the operations are carried on from her deck, on which are large derricks and the necessary tools for working the bell, together with the machinery for furnishing air and electric lights. At the time we passed, the bell was down and nothing could be seen of its working, but it is said to be furnished with movable arms for prying up plank and removing obstructions. Several tons of copper were taken into Alpena, a few days before, the ingots being marked "O. M. Co." Tradition has it that there is a safe with valuables inside, but this has not been found. Neither has there been any trace of the bodies that went down in the wreck.

The elegant passenger ship "Northland" was passed, and it would certainly do credit, as far as appearance goes, to any Atlantic steamship line. This was her last trip for the season, and it certainly seems a pity that two such expensive boats can only be used for a few months each year. The most remarkable improvement for navigation is the Hay Lake Channel, by which a [illegible] and shorter route by eleven miles is had, than [illegible] old channel of St. Mary's River, which was tortuous and almost impossible to navigate at night. The new channel is protected by a dike in Middle Neebish, while just above this a dredge was at work deepening the turn into Hay Lake. At the upper end of Hay Lake a cut has been made the entire distance through the point of Island No. 1. Soon after passing this, the rapids of St. Mary's River are reached and the great locks at Sault Ste. Marie come in sight. These are the largest in the world. Our boat and two others were locked through at the same time, and there was still room for a fourth vessel. The old lock, which is parallel to the new one, is used only in emergencies.

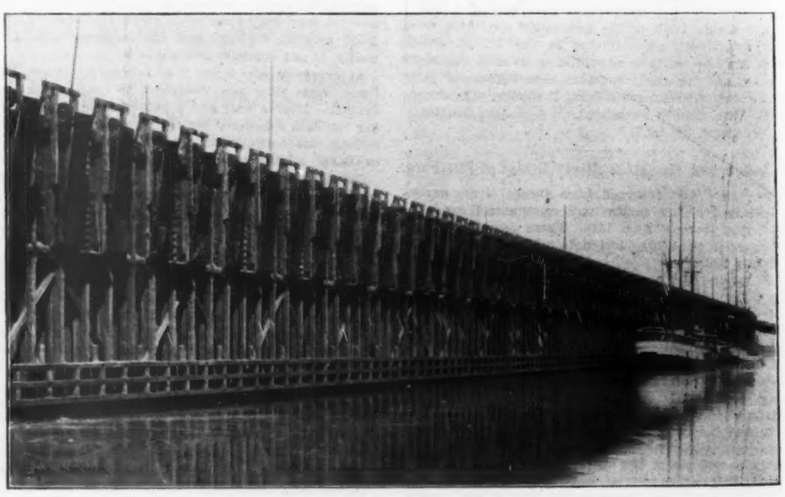
Four huge drawbridges are to be seen, two on each side of the river, and it was "a toss-up" as to which was the ugliest one. But as a beautiful drawbridge has never yet been constructed, there is no recourse except to hope that some day some one may find a way to make them at least inoffensive. The lower one over the American canal has a floor, but no approaches and no evidence of travel of any sort. One arm was provided with a large number of levers underneath the floor and such a mass of machinery that it was quite a mystery, until it was learned that it was used to keep the canal free of ice. From the canal, our boat passed out into Lake Superior, where the water tanks were filled, as the captain said it was the best water found in any of the lakes for drinking purposes. Marquette was reached early in the morning, and certainly no city in the country has a finer natural location. The elevation above the lake gives it a fine outlook, and the white front of Hotel Superior could be seen for a great distance out. There are three large ore docks directly in front of the town. One of these has been condemned and another seems to be in bad shape, as the heavy loads have caused the piling to lean in shore and the bents to lean out. The large dock has 270 ore pockets, and our vessel had been loaded in 51 minutes when all the pockets were full, but on this trip several hours were consumed in waiting for the unloading of cars, which were short dump cars 21 ft. long and having capacities of only 20 to 25 tons. When the chutes are lowered down the keys are driven out from the hopper doors and the ore rattles down into the boat "like a thousand of brick." The newer chutes are made of ½-in. boiler iron and are about 3 ft. across. They are wound up by a windlass, the chain winding around a spiral wheel, which hastens the raising as the chutes rise higher.

The breakwater is being rebuilt of concrete monoliths and the portion finished is a fine piece of work. The work was illustrated and described in Engineering News of Jan. 21, 1897. At the mouth of Dead River, 1½ miles north, are the new docks of the Lake Superior & Ishpeming Ry., which are built out into Marquette Bay. A new breakwater is being built here as a protection to the new docks and the lumber docks of the Dead River Saw Mill Co. This breakwater will all be constructed of timber cribs filled with stone and will be about 1,000 ft. long when entirely completed.

The trip down the lakes was made at a speed of 10.8 miles per hour, making the time for the entire trip of 1,218 miles a little less than five days. The most primitive part of the entire process of ore transportation is the unloading. This is accomplished by the best of machinery, in the form of bridge hoists, but the ore must still be loaded into the buckets by hand, with pick and shovel. Some form of bucket hoist could doubtless be worked in the soft ores, similar to bucket dredges; but the harder ores are not easy to handle in any shape.

C. E. F.

Sept. 13, 1897.



ORE DOCK AT MARQUETTE, MICH.

ANOTHER COURT DECISION REGARDING THE USE OF A COAGULANT IN MECHANICAL FILTERS.

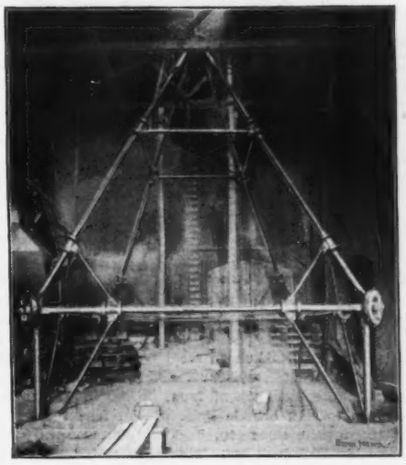
A sweeping decision regarding the use of alum or other coagulants in mechanical filters has just been rendered by Judge Coxe, of the U. S. Circuit Court for the Northern District of New York. Under this decision it appears that any use of a coagulant in mechanical filters, without previous sedimentation of the water and coagulant in an intermittent settling basin of relatively large capacity, is an infringement of the patent, No. 298,-740, granted to Isaiah S. Hyatt, on Feb. 19, 1884. The validity and scope of this patent has been the subject of much litigation for years past. About 1890 a bitter fight was begun between the National Water Purifying Co. and the holders of the Hyatt patent. This suit was terminated by joint consent, and the conflicting parties, with other interests, consolidated as the New York Filter Co. The latter company was succeeded by the New York Filter Manufacturing Co., which now controls the Hyatt patent.

It was commonly reported at the time of the consolidation that doubts regarding the validity of the Hyatt patent were largely influential in inducing the Hyatt interests to consolidate with the National Co. However this may be, the new company soon brought suit against the proprietors of a New York bathing establishment, who were using a Jewell filter, alleging an infringement of the Hyatt patent. This suit was decided against the defendants, including the O. H. Jewell Filter Co., who made the filter in question. In this filter no settling basin was employed. The Court of Appeals, in its decision in this case, stated that in some of the plants of the defendant filter company settling basins were used between the introduction of the coagulant and the filter bed, and that in such cases "there is no infringement." The decree containing this language was made in January, 1895.

Immediately after the decision just mentioned the New York Filter Manufacturing Co. brought action against the Niagara Falls Water-Works Co. to restrain it from using a Jewell filter plant in which small settling basins were employed. The district court decided in favor of the complainants, and the decision was affirmed by the U. S. Circuit Court of Appeals, both courts holding that the amount of sedimentation in this plant was not definitely established by the defendants, was small in amount any way, and that the admission of alum to the water, the sedimentation and the filtration were practically simultaneous, so far as the points at issue were concerned. The final opinion in this case was rendered in May, 1896.

The latest decision relates to a Jewell filter plant at Elmira, N. Y., put in operation early this year. Relatively larger settling basins were employed here than at Niagara Falls, and extensive tests were made for the purpose of demonstrating that the settling basins played a very important part in the plant. Testimony was introduced by the defendants to maintain this point, and also to show that the Hyatt patent had been antedated, both by other patents and in practice. The complainants combatted all this, and Judge Coxe decided in their favor, as follows:

> I have examined with care all the testimony relating to the only question now open—the question of infringement.
>
> In view of what has been said heretofore by this court and the Circuit Court of Appeals, it will serve no useful purpose to discuss this question at length. Suffice it to say that, in my judgment, the Elmira plant infringed the Hyatt patent. The defendants seem to entertain the opinion that they may use the Hyatt process if they use something else in connection with it. I do not think so.
>
> The real work of purification at Elmira is done by the Hyatt process. The cisterns underneath the filters may or may not be an improvement, but the filters act in precisely the same manner as those which have already been condemned by the courts. The tanks are larger than in the Niagara case, and the sedimentation is greater, but the difference is one of degree only. If a tank through which a continuous flow of water passes in eddying currents can become a "settling basin," the Niagara tanks are within this category as fully as these at Elmira. Tanks of this type are not the settling basins of the prior art to which the Appellate Court alluded in the closing sentence of its opinion.
>
> It would have been better for the complainant if the Court had voided the patent in limine rather than place a construction upon it which enables anyone to infringe who has wit enough to pass the water on its way to the filter through a cistern where some of the impurities are caught. Upon the theory of the defendants' water of precisely the same degree of purity might be passed to the filter bed from two distinct sources; if conducted there direct, it would be an infringement, but if passed through a tank, where the coarser impurities are caught, it would not be. In each instance the water actually filtered contains the same amount of impurities, but in the latter it is found more convenient, owing to its greater turbidity, to arrest some of the coarser impurities before introducing it to the filter bed. In both cases the Hyatt process is used.
>
> It is due to the defendants, I think, in order to avoid further misunderstanding to say that, in my opinion, they cannot invade the patent upon their present theory. Even



Metal Beacon for the United States Light House Board.
(From a Photograph of the Structure Erected in the Shops of the Builders.)
Designed by Capt. John Millis, Corps of Engineers, U. S. A.
Built by the Russell Wheel & Foundry Co., Detroit, Mich.

> though they should increase still further the capacity of the cisterns through which they pass the flowing stream it would not avail them. The test at Elmira has been severely criticised by the complainant as unfair and misleading, chiefly because lime was used and also an unusually large amount of alum.
>
> There certainly is foundation for complainant's contention that the plant could not, with good results, be operated practically as it was experimentally. Assume, however, the test to be fair, I am of the opinion that the results obtained fail to show that the defendants' cisterns are settling basins in the sense so frequently alluded to. The motion is granted.

The above decision was rendered in the district court, by the same judge who decided in favor of the complainants in the Elmira case. The first decision against the Jewell filter was made in another district, but affirmations of both the first and second cases have been made by the same appellate court, the district judge in the first case being one of the appellate judges in the circuit in question. Should the case come up in still other circuits, as it must if both parties continue the fight as long as possible, there is a possibility that it may yet go to the United States Supreme Court, but probably no decision could be secured there before the expiration of the patent in February, 1901. The case would go to the Supreme Court, as we understand it, only in the event of a conflicting decision by an appellate court in some other circuit. The outcome of the matter is of immediate importance to all users of coagulants in mechanical filters, except those operating under the Hyatt patent. It was claimed by the defendants, after the appellate decision in the first case, that infringement would be avoided if a settling basin were used. The court in the last case, the Elmira, seems to hold that no matter how large a settling tank is employed, the patent is infringed so long as the tank is operated on the continuous plan. In other words, to avoid infringement, water into which alum has been introduced must be brought to absolute rest in a tank and kept so until a large amount of sedimentation has taken place before it can be filtered. It was such a tank as this, or one operated on the intermittent plan, that the court believes Mr. Hyatt had in mind when he declared in his patent specification that his process would obviate "the necessity of employing settling basins."

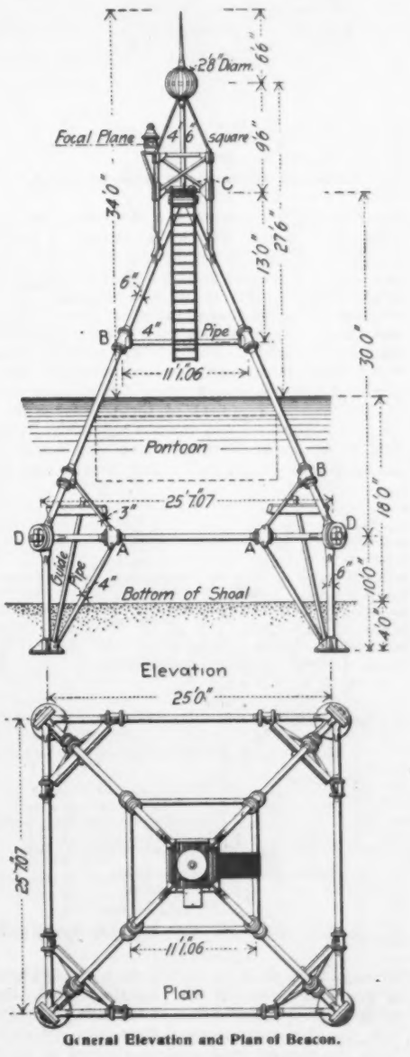
THE LIGHT-HOUSE BOARD'S NEW METAL BEACONS.

The U. S. Light-House Board, on Aug. 13, 1896, invited proposals for the construction of the metal-work of beacons intended for day marks and for survey stations. The Russel Wheel & Foundry Co., of Detroit, Mich., was the successful bidder for the work, and to the courtesy of that firm we are indebted for the material here used.

This beacon may be described as a skeleton framework made up of four upright, four horizontal and four inclined steel forgings, each 6 ins. diameter. The upright members are set in foundation steel castings and they meet the horizontal and inclined members at four special joints of steel castings held by forged steel rings shrunk into place. The upper ends of the inclined members make up a similar joint, held also by a steel ring. The detail of this construction is clearly and fully shown in the illustrations given herewith.

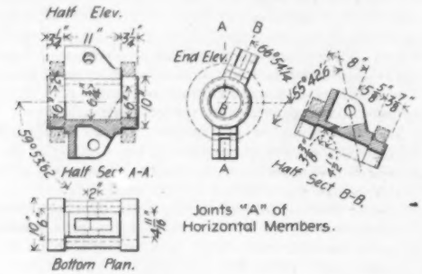
The foot-disks of the beacon are to be jetted into place and the pipe-plan of the apparatus required for this purpose is shown. The system of 2½-in. pipes surrounds a frame made of 3×3×½-in. angle bars, attached to the pipes by eight steel "pipe-holders." At each corner of the pipe-frame is a 1½-in. stop-cock, with hose connection to the jet-pipe, and there are two 2½-in. hose connections with the vessel, with a 2½-in. gate-valve between them. The water will be conducted to the foot-disks by 4 1½-in. jet-pipes, with the lower opening reduced to 1-in. diameter and the upper end fitted for a 1½-in. hose connection. Each hose will be 40 ft. long and must stand a hydrostatic pressure of 150 lbs. per sq. in. above the atmospheric pressure.

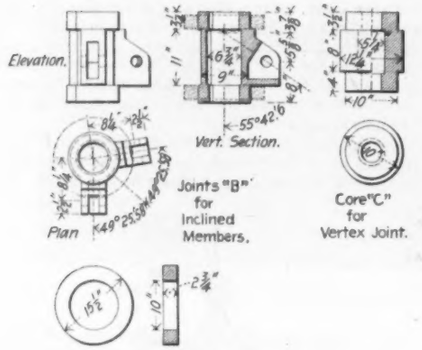
The specifications called for the erection of these beacons at the shop upon a substantial scaffolding, and when all parts were in place and fitted, accurate measurements for the bore of the steel rings were to be taken in the presence of the agent of the Light-House Board. The structure was then to be inspected and properly marked,



General Elevation and Plan of Beacon.

taken down and prepared for shipment. For temporarily clamping the ends of the members during this inspection and measurement for the steel rings, five welded rings of wrought iron had to be provided. The photograph shows this shop erection and inspection. When set up the joints





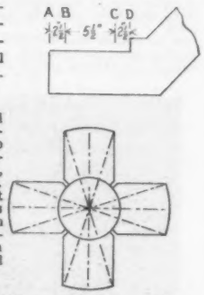
Joints for Horizontal and Inclined Members.

were carefully calipered and the permanent steel rings were bored, with an allowance of 1-60-in. per ft. for the shrinkage fit. As this joint is made up of five machined surfaces, that is, the turned surface of the core-casting and the outer and inner surface of the four meeting members, it is evident that some very nice machining was required to make a perfect fit; especially, as in the case of the inclined members the turned surfaces forming parts of the upper and lower joints, were about 35 ft. apart. The first of these beacons to be erected in the field was the one located at Pollock Rip Shoals, near Boston, Mass., which was put in place on Sept. 16, 1897. This beacon was first erected in dry dock at Boston, on a wooden barge or pontoon, towed to its location, and then grounded in 14 ft. of water at low tide. The Pollock Rip Shoals site is about four miles out at sea from the nearest land, and is exposed to strong currents and very heavy seas.

In this connection, and with pardonable pride, the builders send us a copy of the official report upon this calipering as made by the government engineer. This report is appended and speaks for itself.

Memorandum of Caliper Measurements of Joint Diameters—Beacon No. 2. Constructed by the Russell Wheel & Foundry Co., Detroit, Mich., April, 1897.

(The accompanying cut will make clear where the measurements were taken to determine the joint diameters. The nominal diameter of joints V., VI., VII., and VIII., was 20 ins. The nominal diameter of joint X. was 22.25 ins. The figures in the table represent at each point the number of thousandths of an inch by which the joint exceeded its nominal diameter.)



At point.	V			VI			VII			VIII			X		
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
A.	2	2	2	3	2	3	3	3	4	4	3	3	3	3	4	4	4	4	3	3	3	2	2	2	5	5	6	6	5	
B.	2	2	2	3	3	2	3	3	4	3	4	4	3	3	4	4	4	4	3	3	2	2	2	2	5	5	6	6	6	6
C.	2	3	2	2	3	2	3	3	3	3	5	4	3	4	4	3	4	4	3	3	3	3	2	2	6	6	5	6	6	6
D.	2	3	2	3	4	3	3	3	4	4	3	4	3	3	4	5	4	3	4	4	4	3	4	3	5	7	6	7	6	6

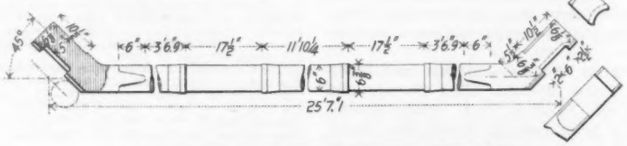
The specifications demanded high grade material and finish throughout. All members, braces, pins, tie-rods, fish-plates, angles and bars were to be made of open-hearth steel which had not more than 0.06% of phosphorus, and 0.04% of sulphur; an ultimate strength of from 58,000 to 65,000 lbs. per sq. in., an elastic limit of not less than 47% of the tensile strength, and an elongation of not less than 25% in 2 ins. This steel must bend cold 180° to a diameter equal to the thickness of the test piece without fracture on the outside of the bent portion. All rings were to be made of open-hearth steel, which has not more than 0.04% of phosphorus and 0.04% of sulphur, with an ultimate strength of from 54,000 to 62,000 lbs. per sq. in., an elastic limit of not less than 47% of the tensile strength, and an elongation of not less than 28% in 2 ins. The steel must bend cold 180° flat upon itself without fracture on the outside of the bend. The steel for castings was to be made either by the open-hearth or crucible process, and must have not more than 0.06% of phosphorus, and 0.06% of sulphur, with an ultimate strength of from 58,000 to 70,000 lbs. per sq. in., an elastic limit of not less than one-half the tensile strength and an elongation of not less than 14% in 2 ins. This steel must bend cold 90° to a diameter equal to three times the thickness of the test piece without fracture on the outside. The wrought-iron used was to have an ultimate strength of not less than 50,000 lbs. per sq. in., an elastic limit of not less than one-half the tensile strength, and an elongation of not less than 18% in 8 ins. The cast-iron, on test pieces 1 in. square, must be capable of sustaining a center load of not less than 2,250 lbs. on a clear span of 12 ins. It must be light gray in color, close grained, not too hard, and uniform in shrinkage. The forgings and material necessary for this work were secured by the contractor in the rough and finished complete in his shops.

This beacon is surmounted by a spherical day mark, with a steel pinnacle and a platform 7 ft. 6 ins. square of 3×3×½-in. angle bars, floored with ½×2-in. steel bars spaced 2 ins. apart. A steel ladder, with wrought-iron rounds, extends from the horizontal brace of the inclined members to the platform, and a bracket for a lens lantern is provided.

These beacons were made from the designs and under the supervision of Capt. John Millis, Engineer Corps, U. S. A,. and Engineer-Secretary of the Light-House Board. The design is altogether new in beacon construction and is correspondingly interesting.

LORD KELVIN'S INSPECTION OF THE GENERAL ELECTRIC WORKS.

A notable event of the past week was the visit of Lord and Lady Kelvin to the Schenectady Works of the General Electric Co., on Sept. 24, and his reception there by the principal officers of that company, and by a number of prominent engineers, who were invited to visit Schenectady through the courtesy of the General Electric Co. Among these guests were: Count di Brassa-Savor-



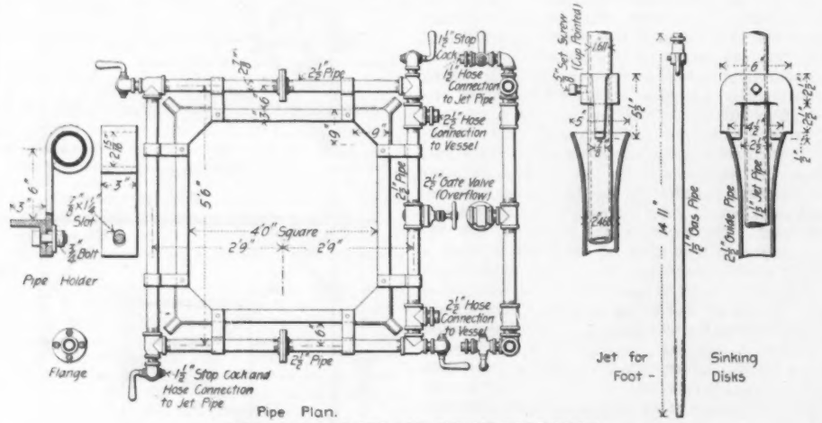
DESIGN OF ONE OF THE HORIZONTAL MEMBERS.

guan, Rev. Elephant U. Potter, Mr. Alanson Trask, Mr. Spencer Trask, Mr. Foster Peabody, Mr. R. R. Bowker, Capt. Eugene Griffin, E. W. Rice, Jr., Prof. Elihu Thomson, S. Dana Greene, C. P. Steinmetz, Dr. Louis Duncan and Mr. Carey T. Hutchinson.

In the heavy machine shop were seen the many machines which have been devised specially for the manufacture of dynamo parts. All of these machines are operated by electrical motors, and many of them are so arranged that the work is kept stationary and the cutting mechanism is moved from point to point where machining has to be done. Among other machines of interest in this building particular attention was called to the largest boring mill ever built, and some very large planers.

In the large testing room, every machine, before being shipped, is subjected to a thorough test to make sure that it is perfect in every respect.

The building in which this testing is done is 400 ft. long by 100 ft. wide, light and airy, and equipped with every sort of appliance for handling the machinery with the utmost rapidity and precision. Ranged on both sides of the center aisle were machines of all sorts and sizes, from the smallest sizes to generators capable of supplying 30,000 lamps. There were also some large dynamos for railway work—seven built for the Metropolitan Traction Co., of New York, of 1,500 HP. each, for use in connection with the electrical equipment of the Fourth and Sixth Avenue railways; and three, for Boston, which have an output of 2,000 HP. each. In addition to these were some large power transmission machines; two of 1,000 HP. each, for the western part of Canada; five of 800 HP. each, for the Falls of St. Anthony. Attention was called to some transformers, for Niagara Falls and Buffalo of 1,250 HP. each, wound for a pressure of 20,000 volts. There was one of the two 1,200-HP., smooth core lighting machines, being built for the Edison Illuminating Company, of New York. These machines are the



PIPE PLAN AND JET FOR SINKING FOOT-DISKS.

largest of the kind ever built, and will together supply 30,000 16-c. p. lamps.

Five 700-HP. rotary converters, for St. Anthony Falls, were pointed out. Rotary converters of this type are fast coming into use, since they require almost no attention, and their efficiency is over 95%.

Connected to the testing room, and forming a part of it, are the machine shop and the shipping department. The total length of these buildings, all under one roof, is 1,320 ft. Electric cranes run the entire length of the building.

The armature building and testing department was next visited. In this building the distinguished visitor was especially interested, and kept his pencil and note book in constant use jotting down the answers to his many questions. Among the special tests shown here may be mentioned the insulation test of the large stationary armature of a 3-phase generator designed to operate at 6,600 volts. In this the insulation was subjected to a pressure of 30,000 volts, which it safely withstood. The method employed in testing armatures of street railway motors was shown, also an exhibit of glass puncturing by a current under a pressure of 45,000 volts. Lord Kelvin was then taken to the other end of the large testing room, where a 1,000-ampere fuse was blown, and a 1,000-ampere magnetic circuit-breaker operated. The method of testing street car motors was next shown, after which the operation of the company's magnetic surface railway was exhibited. We hope to publish a detailed description of this later. The controller testing department was next examined, after which the visitors mounted the tower, from which an excellent view of the works and surrounding country was obtained. Upon descending, and just before entering a street car equipped with electric brakes, Mr. McGhie, the company's enterprising advertising manager, secured an excellent picture of the party. The special car mentioned employs an electric brake known as the "friction disk type," which is independent of the trolley circuit since it uses current generated by the car motors. In this way no power is wasted, the momentum of the car being the source of braking energy. This ended the morning inspection, and the party separating for dinner, Lord and Lady Kelvin and Prof. Thomson were driven to Mr. S. Dana Greene's, while the others partook of a substantial repast at the Mohawk Club, presided over by Messrs. Conover and Clark.

During the afternoon those not forced by business to depart were treated to a very satisfactory exhibition of the Sprague multiple unit system, during which a train consisting of four regular elevated cars was started, stopped and run back and forth, at various speeds, up to 25 miles per hour. Starts were made, using the motors on one car, then on two, on three, and finally with all motors operating. The remarkably increased tractive effort and rapid acceleration of the system was thus well shown. Acceleration runs were next made on a special car to illustrate a series of experiments, being conducted by the company to determine the maximum rate of acceleration which will not be annoying to passengers. Several starts were made, during one of which a speed of 30 miles per hour was attained 10 seconds after starting.

A few members of the party continued the inspection through the wire and cable department and shop devoted to sheet iron stampings. In the former machinery for insulating wires from the smallest to the large lead-covered cables was in full operation, affording a clear idea of the process of the care necessary to turn out good material and manufacture. In the latter, some of the dies pointed out were remarkable pieces of construction on account of their large size and extreme accuracy.

Throughout the entire tour every opportunity was afforded the visitors to examine the apparatus and methods employed by the company, and efforts were made to make their brief stay as pleasant as the rainy day would permit.

Lord Kelvin's opinion was well expressed when he said: "I am enjoying myself very much and learning enormously. There are no shops in the world like these; they are among the great wonders of America." And his frequent questions, intense manner, and constant use of note book and pencil gave further evidence of his interest in and admiration of the great works exhibited to him.

ACCIDENT TO A CONCRETE-COVERED RESERVOIR AT WELLESLEY, MASS., WHILE UNDER CONSTRUCTION.

A portion of the concrete elliptical groined arch roof over the water-works reservoir at Wellesley, Mass., fell while under construction about Sept. 15. The accident appears to have been due to the removal of struts placed to take up the horizontal thrust of half of the roof prior to the completion of the remaining portion, as explained below. A quarter plan and half sectional-elevation of the reservoir are shown by Fig. 1, and a view of the structure after the accident by Fig. 2. Mr. Freeman C. Coffin, M. Am. Soc. C. E., of 53 State St., Boston, is the engineer for the work, and Mr. D. Cuozzo, 150 Nassau St., New York city, is the contractor. We are indebted to Mr. Coffin for the illustrations shown, and for the following account of the accident:

The reservoir is 82 ft. in diameter, with vertical concrete walls 15 ft. high to the springing line of the groined elliptical concrete arches, which are supported on brick piers 24 ins. square and 14 ft. c. to c. The rise of the arches is 2½ ft., and their minimum thickness at the crown is 6 ins. The spandrels are filled level with the crown on top, making 3 ft. of concrete over the piers. The concrete arches are being laid with quick-setting Alsen Portland cement, 1, 2½ and 4½; all other work is being laid with Brooks Shcobridge Portland cement. The covering arches were put on in one-quarter sections of the whole roof, and struts were provided from pier to pier and to the opposite wall to sustain the horizontal thrust of the completed arches until the future arches were in place. In preparing to place the centers for the future arches these struts were removed along the center (one-half of the roof being completed), four out of five struts, I am informed, being removed, thus leaving the thrust of the center line of arches unsupported except by the tensile strength of the concrete and the resistance of the piers. The arches stood in this condition over night, and when three workmen went on the roof at about 7 o'clock the next morning the six arches along the center line were pushed outward and fell. The remaining piers and arches were left standing and remained so until they were again braced to the opposite wall.

Messrs. Desmond FitzGerald, F. P. Stearns and H. A. Carson, all Members Am. Soc. C. E., were asked to examine the reservoir after the accident. They reported to the committee in charge of the building of the works that they approved the plans, and advised that the roof be at once completed in accordance with them.

I will add that the concrete in the first quarter had been laid three weeks and that in the second one week. About

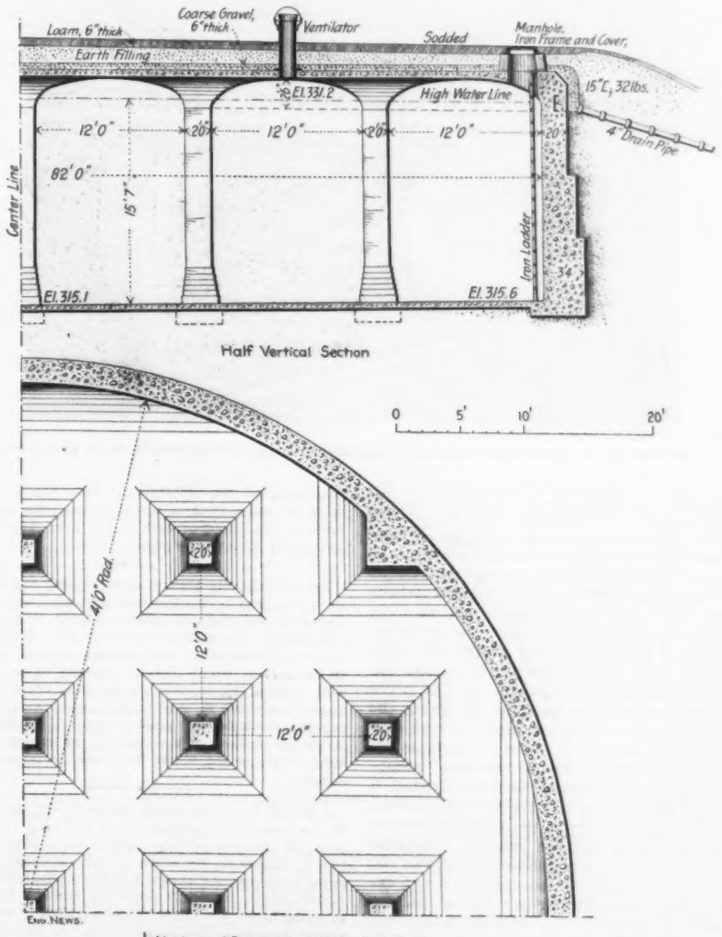


FIG. 1.—PARTIAL PLAN AND SECTIONAL-ELEVATION OF THE CONCRETE COVERED RESERVOIR AT WELLESLEY, MASS.

Mr. Freeman C. Coffin, M. Am. Soc. C. E., Engineer. Mr. D. Cuozzo, Contractor.

20 ins. of earth was laid on the former and 6 ins. on the latter, from which the centers had just been withdrawn.

One man was killed; one had his leg broken and is doing well; two were slightly injured and are now at work, I believe.

The cost of replacing the work that fell will probably not exceed $500 or $600.

THE LATEST JERSEY CITY WATER SUPPLY SPECIFICATIONS.

Specifications for a permanent water supply for Jersey City have been submitted to the Board of Street and Water Commissioners by Mr. C. C. Vermeule, 208 Broadway, New York city, and Mr. Garwood Ferris, of Jersey City, Consulting Engineer of the city. It may be some weeks before bids will be called for, as the specifications must first be approved by the above board, the Board of Finance, and the Mayor. There are four sets

of specifications, three being for gravity supplies under different conditions, and one for the filtration of the present supply from the Passaic River. Plan A is for a gravity supply of 50,000,000 gallons per day, delivered through one pipe line at an elevation of 210 ft. above tide. This would supply the whole city by gravity. Plan B is for water rights to the extent of 70,000,000 gallons a day, with works at the outset capable of delivering 35,000,000 gallons per day, through one pipe line, to an elevation of 210 ft. Under this plan the contractor would be obliged, on demand of the city, to increase the works to a capactiy of 70,000,000 gallons per day, the increased amount to be delivered through a second 35,000,000-gallon pipe line, but to an elevation of 127 ft. only, or for the low service supply, at the present reservoirs. Plan C is like Plan B, except that both pipes would deliver water at an elevation of 127 ft. All three specifications call for storage reservoirs. They also provide that the contractor must use all legal powers vested in the city to prevent pollution, and failing in this he must build intercepting sewers. All bids are to give the price per million gallons at which water will be furnished, and also the price at which the city may buy the works at completion and acceptance, and at the end of 5, 10 and 15 years. In case the city is to take the works at completion, the contractor must be given notice within one year of the date of signing the contract. If it purchases subsequently the city must give a year's notice. Plan C provides for delivering filtered water to the present pump-wells. Under it the contractor must install a plant with a daily capacity of 40,000,000 gallons, and increase the capacity of the plant to keep it 20% in excess of the greatest monthly consumption. The filtrate must not contain more than 250 bacteria per cu. cm., on the average, and not exceed 500. The price of water per million gallons must be stated, and also the price at which the city may buy the filtration plant at the end of 5, 10 or 15 years. No price on completion is asked, as it is desired that the contractor operate the plant for at least five years before the city takes possession of it. The above outline of the specifications has been prepared from information kindly furnished by Mr. Vermeule, at our request.

FIG. 2.—VIEW OF COVERED RESERVOIR AT WELLESLEY, MASS., AFTER PORTION OF THE ROOF FELL.

DETROIT'S MUNICIPAL ELECTRIC LIGHTING SYSTEM with the year ending June 30, 1897, was operated at a total cost of $64.19 per arc lamp of 2,000 c. p. for operating expenses and $89.42 per lamp when interest and depreciation on the plant and taxes are added. The municipal plant also operates 3,064 incandescent lamps of 16 c. p. each in the city's public buildings. The total cost for these lamps, including interest, taxes and depreciation, was 34 cts. per lamp hour. It is stated that the arc lamps burn with greater brilliancy and with fewer failures than when they were operated by a private company.

A NEW RECREATION PIER at 24th St. and East River, New York city, was opened Sept. 25 by Mayor Strong with formal ceremonies. Like the pier at the foot of East Third St., whose opening was described in our issue of July 1, this structure consists merely in a substantial platform covering the pier proper and intended for the use of the crowded East Side populace as a recreating ground in summer time. The pier has been built under the direction of the Dock Commissioners, Messrs. E. C. O'Brien, Edwin Einstein and John Monks.

THE $9,000,000 APPROPRIATION for improving the Erie, Oswego and Champlain Canals in New York State will fall short, it is estimated, about $3,000,000 of completing the work laid out by the State Engineer (Eng. News, Sept. 2, 16 and 23, 1897). In the neighborhood of $7,500,000 worth of work has now been completed or contracted for, mostly on the Erie Canal, and it is estimated that the remainder will be barely sufficient to complete the Erie Canal improvements alone, leaving the Oswego and Champlain canals unimproved except in a few places. Press despatches state that in all probability the members of the executive canal committee, representing an association of boards of trade and other commercial bodies of the State, will ask the next Legislature to pass a bill authorizing the State to issue bonds to raise the extra money needed. This appropriation being over $1,000,000, will have to be approved by popular vote.

THE DIAMOND SHOAL LIGHTSHIP, NO. 69, will be put in position on the shoal off Cape Hatteras about Sept. 30. This boat, together with a consort to be located at Fire Island, was built by the Bath Iron Works, of Bath, Me., for $50,000 each. The lightship is to be anchored in 30 fathoms of water, and the mooring chain is made of 9-in. links of 1⅝ in. round iron. This chain will be attached to a 6,000 lb. mushroom anchor. As the strain on this chain will be very great at times, a resistance spring is placed forward of the capstan, so arranged that the strain must exceed 45,000 lbs. before it comes upon the capstan.

A LAKE PORT OF SOME MAGNITUDE, at Waukegan, Ill., is among the possibilities of the near future if the plans of the present City Council are carried out. This city is located on the shore of Lake Michigan, about 35 miles northwest of Chicago, and has a population of about 10,000 people. Some 20 years ago the city had a small shipping trade, but this trade has gradually decreased to almost nothing at the present time. In 1885 the Federal Government completed a pier enclosing a quite extensive harbor for vessels up to 14 ft. draft, but this harbor has been useless for the want of docking facilities. These the City Council propose to build at the expense of the city and it has passed an ordinance for the work. It is stated that contracts will be let soon. The estimated cost of the work is $6,000. W. W. Pearce is Mayor of Waukegan.

A UNIFORMED STREET-CLEANING CORPS is to be introduced in Chicago, as a result of the visit of the mayor and other city officials to New York. The uniform will probably consist of a blue cloth cap, with "S. C. D.," in large white letters on the front; a heavy blue cloth blouse or Norfolk jacket, with belt, and trousers of the same material, with a narrow strip of white at the leg seams. The expense of the uniforms for the first squad will be borne by J. S. Cooper, street-cleaning contractor, in return for a permit to clean the down-town streets by machinery in the night time, though the specifications require the work to be done by hand.

AN OFFICIAL PHOTOGRAPHER'S CAR, equipped with all the necessary apparatus for taking, developing and printing photographs, is one of the latest innovations for exploiting the business and agricultural possibilities of the undeveloped country tributary to American railways. A car of this character has been built by the Baltimore & Ohio R. R., and will be placed in charge of an expert photographer and a man capable of investigating and reporting upon the natural resources and commercial possibilities of the country traversed. The idea, it is said, is to have the car run over the various railways in the country, the photographer taking photographs of the scenery and towns along the route and the expert collecting the material for a complete report of the character mentioned above. The photographs will be used to illustrate the report.

SOME RECENTLY BUILT FOUR-CYLINDER LOCOMOTIVES for the London & Northwestern Ry., of England, indicate that the locomotive truck or "bogie" is steadily gaining in favor in England, even on some of the roads which have been most persistent in their objection to this device as being suitable only for engines running on light or rough track and not for locomotives running on the substantial track of English railways. The fact that even this track is not perfectly smooth and that "bogie" engines are much steadier and safer in high speed service are among the reasons for the change in ideas among English superintendents of motive power. Among the strongest opponents to the bogie system have been the Great Western Ry. and the London & Northwestern Ry. Some bogie engines (with two and four driving wheels) for new express train service on the former road have already been described and illustrated in our columns, and now Mr. F. W. Webb, Locomotive Superintendent of the London & Northwestern Ry., has brought out two bogie engines of the American eight-wheel type, which have been in regular service hauling the heavy fast express trains of the summer traffic. These engines (the "Iron Duke" and "Black Prince") have four cylinders; the former being a four-cylinder simple engine, and the latter a four-cylinder compound, with the high-pressure cylinders outside. The two valves of the high-pressure and low-pressure cylinders on each side are operated by a single Joy valve gear, the motion being taken from the connecting rods of the inside cylinders, with rocker shaft connections for the outside cylinders. The driving wheels are unusually far apart, and have the counterbalance weights arranged close to the hubs. There are two smokestacks, both enclosed by a single oval casing. The general dimensions of the "Black Prince" are as follows:

Driving wheels (4)	7 ft. 0 ins.
Truck wheels (4)	3 " 6 "
Wheelbase, driving	9 " 8 "
Weight on driving wheels	76,160 lbs.
" total of engine	120,960 "
" of tender	60,480 "
Cylinders, h. p. (2) (outside)	15 × 24 ins.
Cylinders, l. p. (2) (inside)	19½ × 24 "
Heating surface	1,400 sq. ft.
Boiler pressure	175 lbs.

PORTLAND CEMENT PRODUCTION IN THE UNITED STATES, for 1896, amounted to 1,543,023 barrels, says Mr. Spencer B. Newberry in his annual report for the U. S. Geological Survey. This output, as compared with 990,324 barrels for 1895, shows an increase of nearly 56%. The import of Portland cement in 1896, aggregated 2,989,597 barrels, as compared with 2,997,395 barrels in 1895. Of this amount Germany supplied 1,366,909 barrels, in 1896, and England and Belgium furnished almost exactly an equal amount, or 742,169 and 742,237 barrels respectively. Of the American Portland cement, Pennsylvania made 825,054 barrels last year; New York made 260,787, and New Jersey made 247,100 barrels. Mr. Uriah Cummings also reports to the U. S. Geological Survey upon rock or natural cement. He places the total product for 1896 at 7,970,459 barrels, as compared with 7,741,077 barrels in 1895. The total value of the product in bulk at the mills for the two years is placed at $3,805,424 and $4,049,202 for 1895 and 1896. The use of cement in the United States has increased from 6.46 lbs. per capita in 1850, to 33.93 lbs. in 1890. Approximately, 65% of the natural cement is now sold in paper or cloth sacks, and 35% in wooden packages. Mr. Cummings calls attention again to the fact there are three distinct standards of weight for a barrel of cement in this country. The Eastern standard is 300 lbs. and the western is 265 lbs. The Portland cement standard of 380 lbs. is common to both sections.

THE CABLE FOR AN AERIAL TRAMWAY to be used to transport ore from the Nellie Mine to the town of Telluride, Colo., was the cause of some anxiety to the engineer in charge. The cable weighed 17,000 lbs. and was 13,200 ft. in length and had to be transported whole up a narrow and dangerous pass, where the trail was not more than 15 ins. wide in parts, to the mine fully 2,500 ft. above the town. The task was finally accomplished by unwinding the cable from the spool and forming it into 128 smaller coiled bundles of 130 lbs. each. These were securely fastened to the backs of burros, two bundles to each animal, making a procession of 64 which slowly wound its way up the dangerous trail. The same evening the cable was running and at present it handles material which previously required 500 burros.